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CIVIL ENGINEERING PREDESIGN REPORT

NORTHSIDE SANITARY LANDFILL AND
ENVIRONMENTAL CONSERVATION
AND CHEMICAL CORPORATION SITE
Zionsville, Indiana

WA 07-5NH2.0 and WA 08-5N30.0
Contract 68-W8-0040

November 23, 1988

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Chapter 1
INTRODUCTION

This Predesign Report summarizes previous site investigative and planning work that will be useful to the civil engineering aspects of the proposed remedial design. It includes descriptions of the site, its history, the proposed remedy, design criteria, data requirements, and other project information. Where appropriate, consideration is given to the probable case that the design will not be performed by the remedial investigation/feasibility study (RI/FS) contractor. The purpose of this report is to facilitate the transfer of information from the RI/FS contractor to the designer.

The Northside Sanitary Landfill (NSL) and Environmental Conservation and Chemical Corporation (also referred to as Enviro-Chem Corporation or ECC) are both on the Superfund National Priorities List (NPL) and are adjacent to each other (Figure 1). During the course of the U.S. EPA's investigations, it was determined that it would be difficult and more costly to implement individual remedies at the two sites because of their proximity. Accordingly, the EPA has selected a remedy to clean up both sites.

The selected remedy identified in the Record of Decision (ROD), dated September 25, 1987, includes the following components:

- Deed and access restrictions to prevent future development of the sites
- A multi-layer cap over both sites that meets the requirements of the Resource Conservation and Recovery Act (RCRA)
- Rerouting of surface waters to reduce the potential for contaminant movement to surface water
- Leachate collection and treatment at the NSL site
- Groundwater collection and treatment at both sites
- Monitoring to ensure the effectiveness of the design components

SITE DESCRIPTION

The ECC and NSL sites lie in a rural area of Boone County, Indiana, south of the intersection of State Route 32 and U.S. Highway 421 and about 10 miles northwest of Indianapolis. The ECC site occupies 6.5 acres immediately west of the

168-acre NSL site. The landfill occupies approximately 70 acres of the NSL site.

The area surrounding the sites is largely undeveloped. Land use to the east and south of the site is agricultural; to the west and north it is residential. There are approximately 50 residences within 1 mile of the site.

An unnamed drainage ditch that separates the NSL site from the ECC site flows into Finley Creek near the southwest corner of the landfill. Finley Creek discharges into Eagle Creek about 0.5 mile downstream of the site. Eagle Creek then flows south for about 9 miles before emptying into the Eagle Creek Reservoir, which is used by the City of Indianapolis for part of its drinking water supply.

The surface of the landfill is generally barren with some areas of sparse vegetation. The sideslopes are steep, and shallow erosion gullies are common. Leachate seeps are periodically evident on all sides of the landfill. Two man-made ditches--one on the north side and one on the east side of the landfill--act as collection ditches for surface water runoff, groundwater discharge, and some leachate. The north ditch drains to the unnamed ditch and the east ditch drains directly to Finley Creek. The north ditch was observed during the remedial investigation to carry a constant baseflow from the landfill. A leachate collection system consisting of three holding tanks and collection tiles was installed by the landfill owner in 1982 to collect leachate along the west and south sides of the landfill.

The ECC site is covered with a silty clay cover except in the southern third of the site where a concrete pad used during site operation is still in place. A sump in the southeast corner of the site collects contaminated water from beneath the concrete pad. Water from the sump periodically discharges to unnamed ditch. The ECC process building is in the northern half of the site. Access to the ECC site is restricted by a surrounding fence.

SITE HISTORY

The Northside Sanitary Landfill is privately owned and operated as a solid waste disposal facility. The site has been operated since at least 1962 and has accepted various industrial and municipal wastes during the course of its operation. The vice president of the company that owns the landfill has estimated that 16 million gallons of hazardous waste have been disposed of in the landfill. A 3-acre oil separation lagoon on the landfill surface is evident in a 1977 aerial photograph. The site has had recurring operational deficiencies as reported by the Indiana State Board of Health (ISBH). The U.S. EPA detected leachate running into Finley

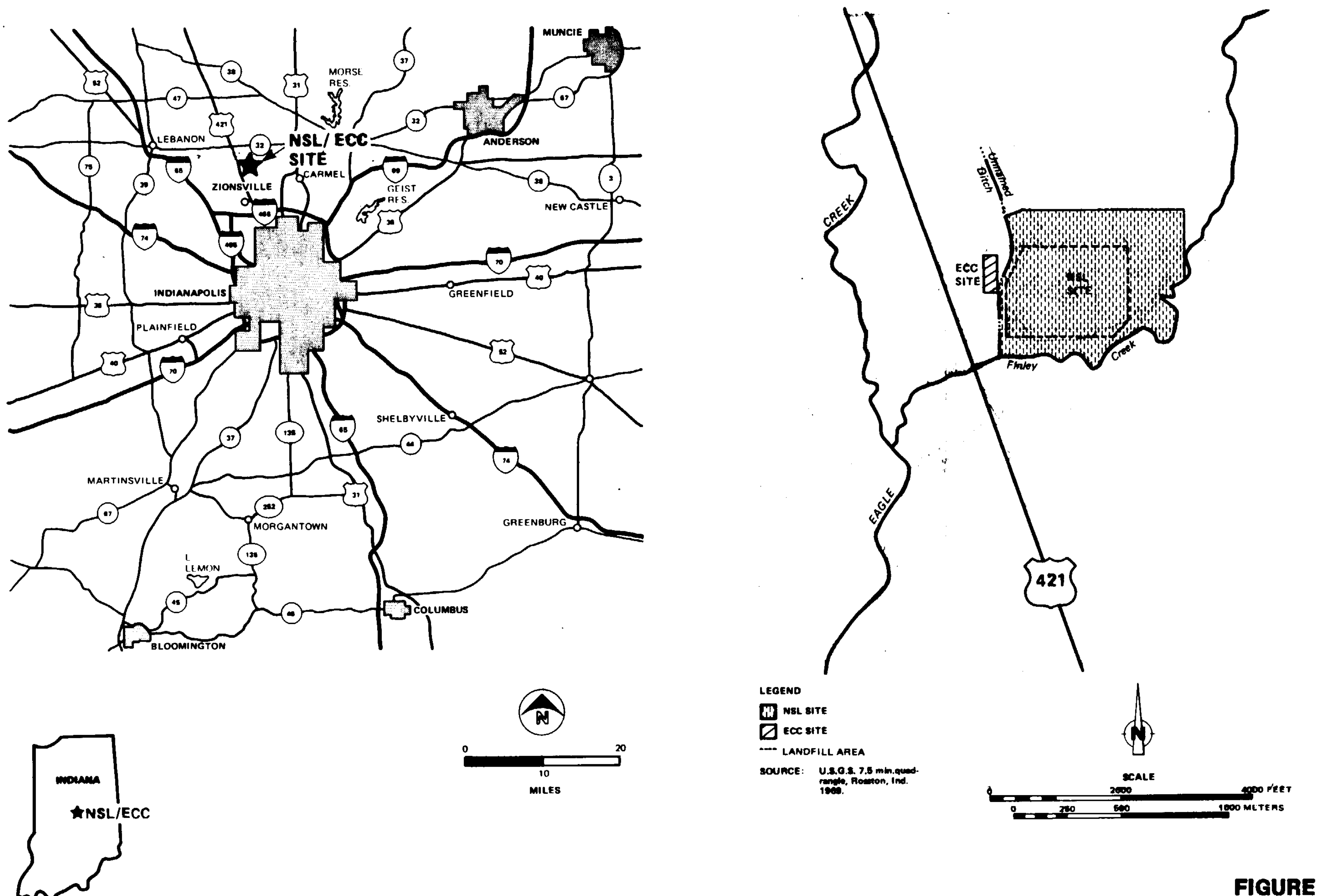

FIGURE 1
LOCATION MAP
NSL/ECC CIVIL ENGINEERING
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Creek, and groundwater contamination was detected in monitoring wells at the site. The site was placed on the NPL in 1983.

ECC began operations in 1977 and was engaged in the recovery, reclamation, and brokering of primary solvents, oils, and other wastes received from industrial clients. Waste products were received in drums and bulk tankers and prepared for subsequent reclamation or disposal. Reclamation processes included distillation, evaporation, and fractionation to reclaim solvents and oil. ECC wastes disposed of at NSL reportedly included 5,000 gallons/month of waste fluids from the ECC oil reclamation process, still bottoms and solvent recovery waste, 50 to 80 drums/day of paint sludge, thinner, stain and resin sludge, and at least 7,000 drums whose contents are unreported.

Drum shipments to ECC were halted in February 1982 after EPA and ISBH investigations showed onsite accumulation of contaminated stormwater, inadequate management of drum inventory, and several spills. In 1983, ECC was placed on the NPL. The EPA subsequently removed, treated, and disposed of cooling pond waters, about 30,000 drums of waste, 220,000 gallons of hazardous waste from tanks, and 5,650 cubic yards of contaminated soil and cooling pond sludge.

WASTE CHARACTERIZATION

Hazardous wastes from a variety of industrial clients were received at ECC. ECC site records report that chlorinated hydrocarbon solvents were processed at the facility. Oils and other wastes were also received; however, poor management of drum inventory resulted in an incomplete list of the wastes processed at the site.

Since accurate records were not kept at the NSL site, a complete inventory of the wastes dumped is not available. However, according to data compiled by the EPA in December 1983, at least 16 million gallons of hazardous wastes had been disposed of in the landfill according to a 103C RCRA notification signed by the Vice President of NSL. A partial list of types of wastes disposed of at NSL is given in Table 1.

SUMMARY OF STUDIES AND AVAILABLE INFORMATION

NSL SITE RI ACTIVITIES

Remedial investigations began in 1984 and continued until November 1985. The scope and purpose of the NSL RI was essentially the same as that for the ECC site.

Surface soils were sampled at four locations on the site. Subsurface soils were taken at 11 of 15 borehole locations around the landfill. Monitoring wells were installed at each borehole location. In addition, a second (nested) well was installed at four locations to make water monitoring of both shallow and deep zones possible. Water levels were measured and conductivity tests were conducted on all monitoring wells. Leachate liquid was sampled in two locations and leachate sediment was sampled in three. Surface water and sediment in the unnamed ditch and Finley Creek were sampled in nine different locations in a two-phased sampling effort in December 1984 and May 1985. Groundwater was sampled in 23 monitoring wells and piezometers in a two-phased sampling effort in February and May 1985.

ECC SITE RI ACTIVITIES

Remedial investigations began in 1983 and continued until December 1984. Soil, hydrogeologic, surface water, and sediment investigations were conducted to define site conditions, identify pathways and receptors, and determine the need for remedial action. Data from previous investigations are described in the RI report.

Soil sampling was conducted in two phases. During Phase 1, 15 surficial soil samples were taken and 15 shallow (2.5-foot) borings were made before removal of 2 feet of contaminated surface soil from most of the site. During Phase 2, conducted after the soil removal, 9 soil borings up to 12 feet deep were taken through the concrete pad on the south 1/3 of the site and 12 test pits were dug to depths up to 10 feet in the remaining areas.

Hydrogeologic investigations included an electrical resistivity survey, test drilling, installation and sampling of 16 2-inch ID PVC monitoring wells, and sampling of 5 residential wells. Wells were installed and sampled in 3 phases to monitor the shallow saturated zone and the deep confined aquifer.

Three onsite and four offsite surface water samples and six offsite sediment samples were taken during surface water investigations.

FS ACTIVITIES

Feasibility study reports for the NSL and ECC sites were released for public comment on December 5, 1986. The reports were based on information gathered during the remedial investigations. Accompanying the completed FS reports was the recommended combined alternative, presented in the NSL/ECC Combined Alternative Analysis (CAA) report.

COMBINED ALTERNATIVES ANALYSIS

The CAA report, released for public comment on December 5, 1986, discussed the study methods used in developing and

Table 1
PARTIAL LIST OF WASTES DISPOSED OF AT
NORTHSIDE SANITARY LANDFILL

Paint wastes and filters from various processes
Waste tar materials
Sulfuric acid
Oily wastes
Hemoglobin diagnostic kits
Acid waste (various types)
Empty drums (roofing sealants)
Still bottom sludge from solvents
Oil and wastewater
Incinerator ash
Casting, grinding sludge
Microbiological treatment sludge
Methylene chloride, polyurethane
Glue, ink sludge, setup rubber waste
Polyvinyl acetate adhesive
Grease trap wastes
Oil soaked sand, straw, and soil
Resin solvents
Spill residual
Roadside dump barrels
Lead contaminated ash
Methylene chloride waste
Waste sludge from recovery of halogenated solvents
Neoprene latex, polyvinyl acetate solvents
Waste treatment sludge K052
Centrifuge sludge F006
Citric acid, urea hydrofluoric acid
Salt bath brazing furnace waste
Cadmium plating waste
Industrial waste treatment sludge
Hard rubber/PVC battery cases
Still bottoms/solvent recovery waste
Plastic scrap film
Sand containing ethyl hexyl acrylat
Ink filters, detergent residue
Polymerized styrene monomer
Paint stain

Source: Northside Sanitary Landfill Remedial Investigation Report

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evaluating remedial action alternatives for both sites. The combined alternatives were derived from alternatives developed for the individual sites. The alternatives were combined to ensure that the remedial actions would be compatible with each other, to avoid duplicate remedial actions, and to reduce costs.

Following the public comment period (December 5, 1986, to February 28, 1987), a responsiveness summary was prepared and included in the ROD along with a description of the selected remedy.

PREDESIGN FIELD INVESTIGATIONS

Leachate and groundwater samples were taken in August 1987 to further characterize the leachate and groundwater in preparation for treatment system design. Predesign Technical Memorandum No. 1 (August 1988) contains further details of this sampling effort.

Geotechnical and hydrogeological field investigations were conducted in the spring of 1988. The geotechnical investigation consisted of 32 soil borings, 13 test pits, 39 cone penetrometer soundings, and 16 nuclear density tests. The data from these field investigations provided essential geotechnical information of surface and subsurface material for engineering design purposes. The investigations were completed in a proposed borrow area located north of NSL, on top of the landfill, and along a proposed groundwater interceptor trench alignment.

The hydrogeological field investigation consisted of drilling 25 soil borings and installing 13 monitoring wells south of the ECC site. The purpose of the investigation was to define the nature and extent of contamination originating from the ECC site. Predesign Technical Memorandum No. 2 (November 1988) contains further details and results of the geotechnical and hydrogeological field effort.

PHYSICAL SITE CHARACTERISTICS

REGIONAL GEOLOGY

The unconsolidated, surficial deposits in the Indianapolis area are attributed to deposition during the Wisconsinan Glacial Stage (Smith 1983). The glacial deposits consist of all particle sizes ranging from clay to boulders. Most deposits were derived from materials reworked from the path of the moving ice sheets and redeposited under pressure at the base of the ice (till) or redeposited by glacial meltwater (outwash). Extensive till deposits, consisting of ice-compacted silty clay matrices containing variable amounts of sand, gravel, and boulders comprise most of the glacial deposits on a regional scale in the Indianapolis area. Outwash deposits from glacial meltwater streams are also prevalent and are generally found along present-day drainageways in this region. Postglacial alluvial stream deposits from present-day streams are also often found overlying or incising glacial outwash channel deposits.

In the vicinity of Indianapolis, an extensive outwash unit of continuous sand and gravel containing isolated boulder, silt, and clay fractions extends along the White River, Fall Creek, and Eagle Creek (Figure 2; Smith 1983). The outwash was deposited and reworked by meltwater streams flowing from the Wisconsinan ice sheet. Discontinuous clay and silt lenses are numerous in the outwash deposits.

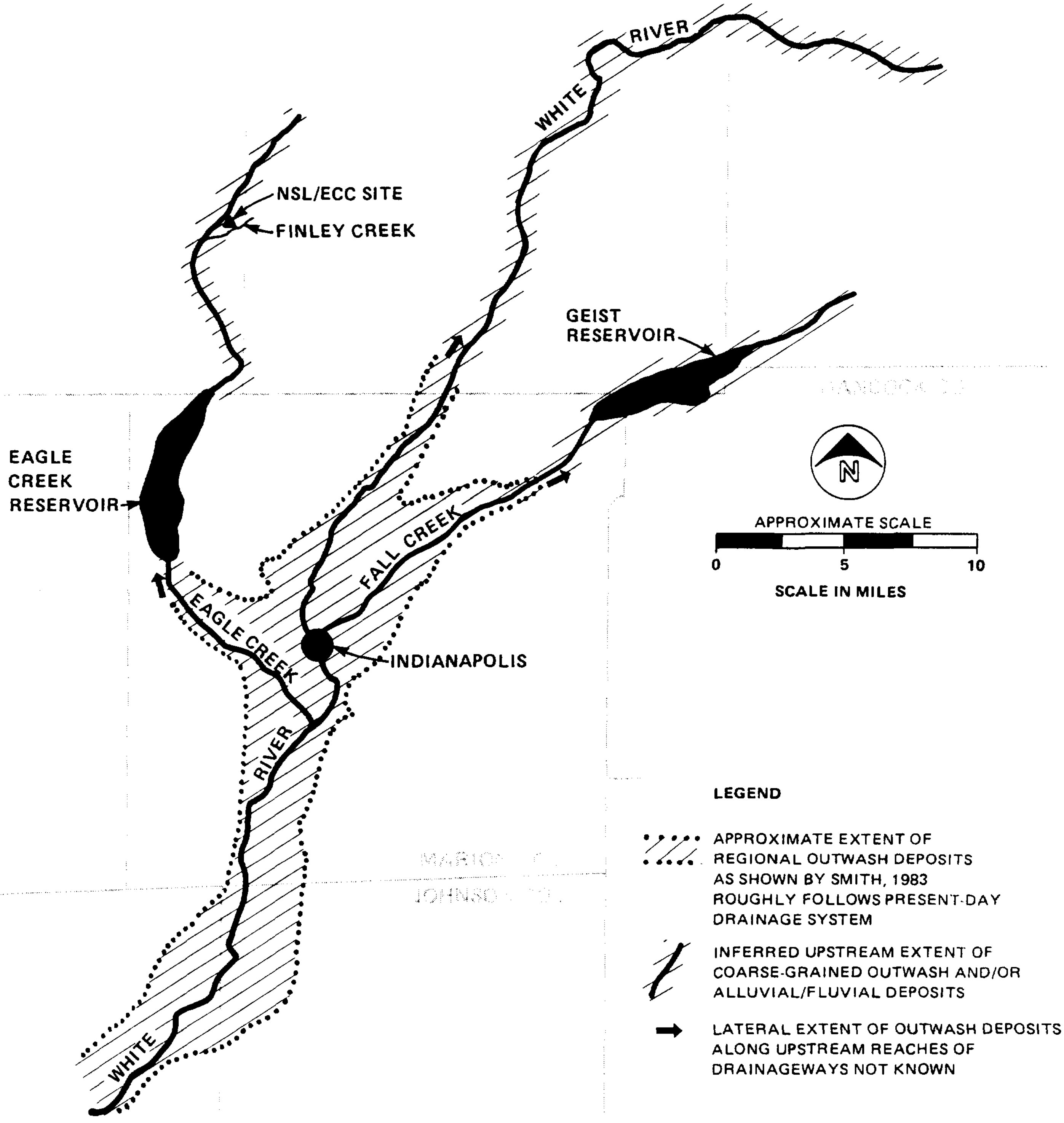
At the edges of the valleys of the White River and upstream reaches of Fall and Eagle Creeks, the outwash deposits interfinger with deposits of the Tipton Till Plain (Smith 1983). The till plain deposits consist mainly of ice-compacted silty clay layers with discontinuous sand and gravel deposits within the till layers. Poorly defined extensions of the till layers may extend into the outwash in some areas.

The bedrock underlying the Tipton Till Plain consists of Devonian and Mississippian age shales and Silurian and Devonian age limestones and dolomites. The bedrock dips southwest toward the Illinois basin at approximately 10 to 30 feet per mile. In general, 150 to 200 feet of glacial sediments overlie the bedrock.

SITE GEOLOGY--UNCONSOLIDATED DEPOSITS

The NSL and ECC sites are located on the Tipton Till Plain. The till plain and related drainageway sediments are typical of those found regionally. As shown in Figure 2, Finley Creek is an upstream reach of Eagle Creek, which is, in turn, an upstream reach of the White River. Coarse-grained deposits are interfingered with the compacted "till" deposits as described in Regional Geology, above. The major surficial units at the site include the following:

1. The predominant surficial unit is a compact, fractured silty clay till containing discontinuous lenses of coarse-grained material. The fractures generally range in thickness from the size of a sand grain to approximately 1 inch. The thicker sand zones or lenses are interpreted to be "englacial" in origin because they are both overlain and underlain by silty clay deposits. The lenses are generally confined, but some are in direct contact with the outwash/alluvium deposits of the Finley Creek drainageway. The englacial sands are distinguished from fluvial/colluvial



ADAPTED FROM SMITH, 1983, FIGURES 1 and 2.

FIGURE 2
REGIONAL DRAINAGE SYSTEM AND RELATED OUTWASH AQUIFER
NSL/ECC CIVIL ENGINEERING PRE-DESIGN REPORT

sands by higher blow counts recorded during standard penetration testing, gray color, and the presence of an overlying till unit.

2. Coarse-grained sand and gravel outwash deposits from glacial meltwater streams are known to exist along former glacial drainageways and probably at depth in the vicinity of Finley Creek. The natural course of Finley Creek probably follows the same general course as that incised in surrounding till plains by glacial meltwater streams.

3. The mixed fluvial/colluvial deposits, probably formed as immediate postglacial deposits, consist of poorly to well graded silts, sands, and angular to subangular gravels. Alternating layers of varying materials up to 6 inches thick in a 2-foot-long soil sample are common. These deposits overlie or incise former glacial outwash deposits.

4. The recent (postglacial) alluvial deposits consist primarily of silt and clay with minor sand lenses and natural organic debris. They may be transitional with underlying reworked colluvial deposits.

HYDROGEOLOGY

Water-Bearing Units

The four distinct water-bearing units that have been delineated for the sites are described below.

Fractured Till. The fractures and englacial coarse gravel lenses within the compacted silty clay till provide preferred pathways for groundwater movement through the till regions. Groundwater movement along those pathways will be orders of magnitude above the reported hydraulic conductivity for the silty clay portion (1×10^{-8} to 1×10^{-9} cm/s; West 1982), but the overall hydraulic conductivity of the fractured till is not known. The direction of groundwater movement is dictated by the geometry of the fractures and lenses. The difference between the hydraulic conductivity of the till and the hydraulic conductivity of the fractures and lenses coupled with the horizontal orientation of the higher hydraulic conductivity zones probably results in a preferential horizontal flow direction.

Englacial Lenses. Groundwater probably moves through the englacial lenses in the till at velocities greater than the average for the overall till unit. Groundwater will flow preferentially through the lenses instead of through the compact clay material.

An extensive englacial sand lens exists within the surficial till unit in the area east of ECC and continues to the west and southwest of NSL. The portion of the lens beneath the southwest corner of the NSL site is near the land surface in the vicinity of Finley Creek and forms a pathway for groundwater to discharge directly to the creek. Cross sections drawn using soil boring information show that the englacial sand lens is in direct contact with coarse-grained fluvial/colluvial deposits found south of ECC.

Coarse-Grained Fluvial/Colluvial Deposits. A unit comprising interlayered fine and coarse sand and gravel has been delineated south of the concrete pad and north of Finley Creek. The coarse material is overlain by fine-grained alluvial silts and clays. Deposition of the units can probably be attributed to glacial and/or postglacial stream activity near present-day Finley Creek. This unit is in direct contact with the extensive englacial sand lens that exists north and east of the fluvial/colluvial unit.

Outwash Deposits. Two zones of coarse-grained outwash deposition delineated for the site are important pathways for groundwater movement. One is a coarse-grained deposit 150 to 200 feet below the land surface of the entire site that is interpreted to be a glacial outwash deposit because of its continuous extent. The deposit constitutes a deep, confined water-bearing unit with higher hydraulic potentials than the overlying units. The potential for upward movement of groundwater from this unit to overlying units precludes the downward migration of contaminants from surficial sources to this deep deposit.

The second known outwash zone onsite is a gully on the NSL landfill site that had once been mined for sand and gravel. The gully is visible on aerial photographs of the area taken before landfill operations commenced (1950, 1955, and 1962 photos; NSL FS, CH2M HILL 1986). The gully bisects the present landfilled area and was partially mined before landfill operations began. The excavated area was then apparently used as an open dump (1962 photos; NSL FS, CH2M HILL 1986). The shape of the gully as seen on the photographs and its expression as shown on topographic maps suggest it is glacial outwash and/or fluvial in nature. The coarse-grained deposits have a high hydraulic conductivity compared to the surrounding till plain, making them a preferential groundwater pathway and another "water-bearing" unit. The gully had been noted to drain toward the unnamed ditch before it was covered (NSL FS, CH2M HILL 1986). As the gully may not have been completely mined, the existence of the sand and gravel deposit beneath landfilled materials may constitute another pathway for leachate to travel from the NSL landfill to the unnamed ditch.

Groundwater Discharge to Drainageways

Regional groundwater flow is from the northeast to the southwest with regional discharge at Eagle Creek (Shaver and Sunderman 1983). Shallow groundwater discharges to Finley Creek and the unnamed ditch. At almost all locations adjacent to those drainageways, upward groundwater gradients exist or the water table is higher than the water levels in the streams, indicating that groundwater is discharged at the drainageways. However, groundwater may also flow underneath the creek at depth. Water level measurements at comparable depths on both sides of the creek are needed to confirm that it is a discharge area.

Figure 3 is a potentiometric surface map of the upper sand and gravel aquifer in the area south of the ECC site and north of Finley Creek. The water levels in the combined, coarse-grained water bearing unit (colluvial/alluvial and englacial sands) were measured on April 29, 1988. Groundwater from the unit is discharging to the unnamed ditch and to Finley creek. Groundwater in the fractured till beneath both the ECC and NSL sites probably discharges into the coarse-grained, water-bearing unit and then into Finley Creek and the unnamed ditch. Also, there is a known direct connection between coarse-grained lenses in the till near the southeastern portion of the NSL site and the banks of Finley Creek.

Leachate Seeps

No groundwater monitoring wells are installed through the landfill itself. Therefore, it is unknown whether groundwater mounding into the fractured till is occurring. If a mound extends into the fill, its saturated thickness is unknown, but it may be small because of the typically permeable nature of the refuse. A limited thickness of perched water and leachate may exist at the interface between the landfill refuse and the ground surface. Water perched within the landfill above the till may be the primary source of the leachate seeps on the landfill's sides.

NATURE AND EXTENT OF CURRENT SITE CONTAMINATION

NSL SITE

Soil samples collected from the surface and subsurface soil from around the periphery of the landfill did not show inorganic concentrations above background soil concentrations. Organic contamination was not found in the surface soil samples of the landfill cover material. Organic contamination of subsurface soil was found in borings nearest the landfill in the southern and southwestern portion of the site. The major organic contaminants found were volatile organic compounds (VOCs) and semivolatile organic compounds.

Leachate seeps, leachate sediment, and leachate collected in the leachate collection system at the NSL site were found to have inorganic and organic contamination. Inorganic contaminants found in leachate included chromium, nickel, and lead. Organic contaminants in leachate and leachate sediment included a variety of VOCs and semivolatile organic compounds.

Groundwater VOC contamination (up to 1,100 mg/l) was found at all shallow NSL wells screened in the glacial till. Semivolatile compounds were found in nearly all wells in the glacial till, though concentrations of individual compounds did not exceed 100 ug/l. Numerous VOCs were detected in the sand and gravel near the southwestern portion of the site at concentrations up to 100 ug/l.

Inorganic contamination of groundwater in the glacial till and the sand and gravel in the southwestern corner of the NSL site included lead and nickel above background levels at several wells. Arsenic, chromium, and cyanide were also found at levels above background in at least one well.

Surface water and sediment contamination in the unnamed ditch and Finley Creek were described for the ECC site. In addition to the contaminants discussed, PCBs were detected in sediment of the old Finley Creek beds south of the NSL site at 1,800 ug/kg.

ECC SITE

Inorganic analysis of onsite soil samples taken during the RI showed that antimony, cadmium, cobalt, copper, lead, manganese, and zinc were present at concentrations exceeding their typical range in soil. Inorganic contamination of the soil is apparently greatest in the near-surface soil (0 to 3 feet) in northern portions of the site.

Organic contaminants found in site soils during the RI were VOCs and phthalates. These compounds are the most widespread organic contaminants and are generally present in the highest concentrations. Organic contaminants were detected at the maximum depth of sample analysis. However, the concentrations and variety of contaminants decreased with depth.

Subsurface soil samples were also taken during the predesign investigation. Inorganic analysis showed antimony, cadmium, and silver at levels above background in the sand and gravel unit. Aluminum, antimony, barium, lead, silver, manganese, mercury, and zinc were found at above-background concentrations in surface fill. Cohesive soils of the upper confining unit had antimony, cadmium, cobalt, mercury, and silver at

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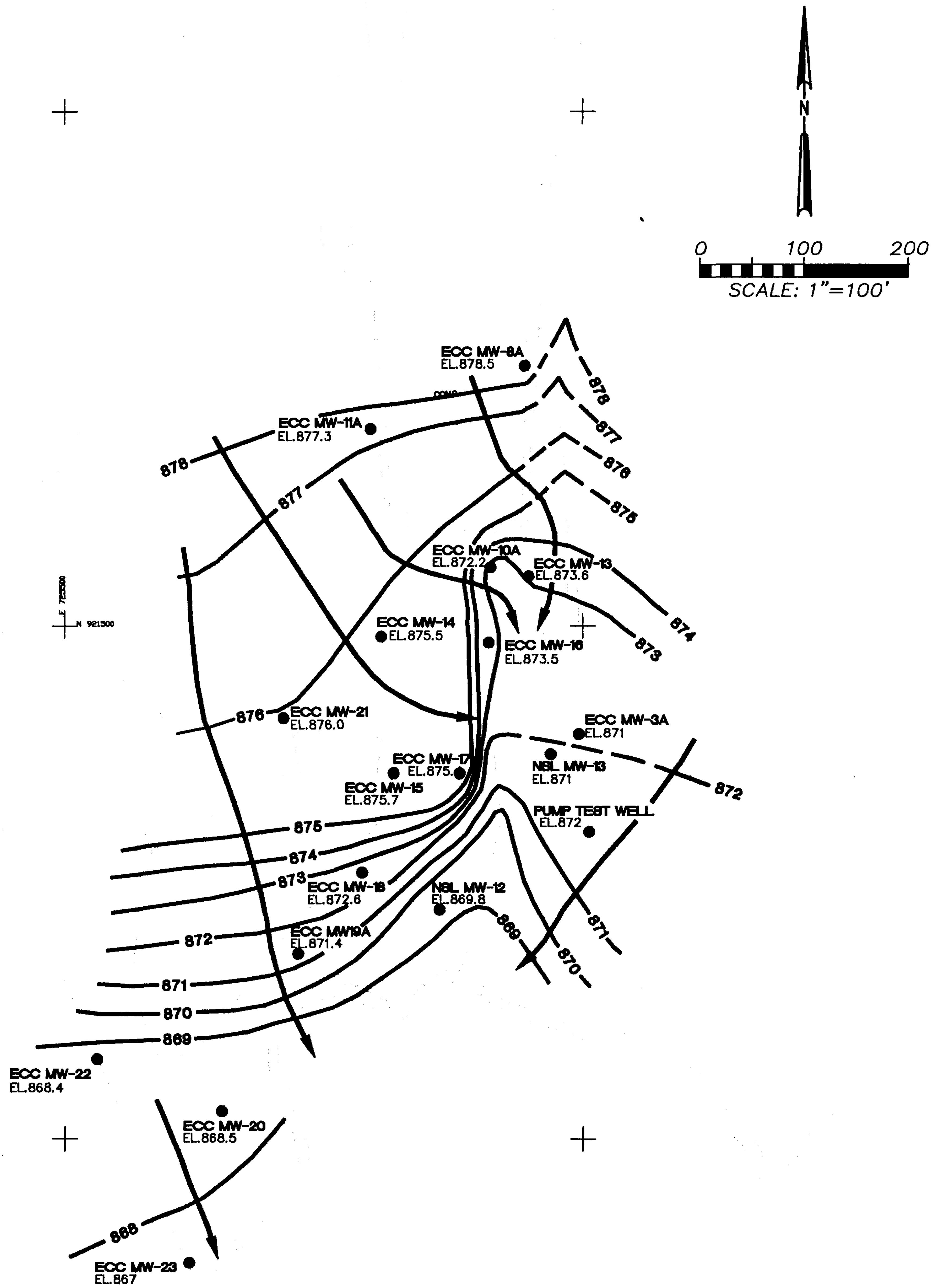

LEGEND

865 POTENTIOMETRIC SURFACE CONTOUR FOR SAND AND GRAVEL AQUIFER. CONTOUR INTERVAL: 1 FOOT.

865 INFERRED POTENTIOMETRIC SURFACE CONTOUR

DIRECTION OF GROUNDWATER MOVEMENT IN SURFICIAL AQUIFER

NOTE: Contours have been drawn to suggest that the pond is not hydraulically connected to the sand and gravel aquifer. This relationship has not been fully established.

FIGURE 3
POTENTIOMETRIC SURFACE MAP OF SAND AND GRAVEL AQUIFER: ECC
APRIL 29, 1988
NSL/ECC CIVIL ENGINEERING PREDESIGN REPORT

CH2M HILL

L65555.DA\FIG3.DWG

levels above background concentrations. Cohesive soils of the lower confining unit had aluminum, antimony, cadmium, chromium, cobalt, and silver at concentrations above background.

Soil contaminants have migrated to the till as evidenced by high levels of organic contaminants found during the RI in one onsite well in the till. The water-bearing unit in the southwest corner of NSL and the south-southeast portion of ECC was found to be contaminated with organics and inorganics during the RI.

Monitoring wells screened in the sand unit and sampled during the supplemental investigation also showed volatile organic and phthalate concentrations. Metals found in the groundwater during this work included arsenic, chromium, copper, lead, and zinc.

The deep confined aquifer below the ECC site has not been found to be contaminated. Future migration of onsite contaminants to the deep aquifer is highly unlikely because of an upward vertical hydraulic gradient from the aquifer.

Migration of contaminants to the nearest residential wells north, west, and south of the ECC site is not indicated by the results of the residential well sampling conducted during the RI.

RI surface water sampling results indicate that cyanide at levels below 30 ug/l is the only inorganic contaminant found in the surface water of the unnamed ditch and Finley Creek. Inorganic sediment contamination is limited to chromium and lead in the unnamed ditch and Finley Creek.

Organic contamination of offsite surface water was found in Finley Creek near Highway 421. Contaminants consist almost entirely of chlorinated hydrocarbons. Surface water ponded on the silty-clay cover on the ECC site was found to be contaminated with a variety of semivolatile and volatile organic compounds. The Indianapolis Water Company has sampled Finley Creek near Highway 421 and several locations in Eagle Creek. Samples taken in 1986 and analyzed for VOCs show VOC contamination in Finley Creek similar to that reported in the ECC RI report. Contamination of Eagle Creek was not found in any of the samples taken. Sediment obtained during the RI from Finley Creek near Highway 421 contained two VOCs and several semivolatile organic compounds at levels up to 300 ug/kg.

SUMMARY OF THE ENDANGERMENT ASSESSMENTS

The endangerment assessments found that potential risks to human health and the environment exist at the ECC and NSL sites. The affected media include soil and landfill contents, leachate, groundwater, surface water, and sediment. They were assessed on the basis of comparison of concentrations at potential exposure points to excess lifetime cancer risks, acceptable daily intake values, and relevant or applicable standards, criteria, or guidelines. The NSL assessment did not quantitatively assess exposures that could occur as a result of new releases of contaminants from the landfill because the nature, quantity, and locations of hazardous wastes within the landfill are not known. Therefore, the nature of future releases is unknown.

The risk analysis performed for the endangerment assessment is conservative and tends to reflect upperbound exposures. However, given the uncertainty in both risk estimation and fate and transport calculations, the actual risks may be lower or higher than estimated. Summaries of the risks associated with the ECC and NSL sites are presented in Tables 2 and 3.

The exposure pathway potentially affecting the greatest number of people is release of contaminants to Finley Creek from groundwater or landfill leachate and the subsequent transport of the contaminants to Eagle Creek Reservoir. Current contaminant concentrations measured in groundwater and in Finley Creek do not result in levels posing a threat to human health when they reach the drinking water intake of the reservoir. This is based on the evaluation of contaminant concentrations assuming dilution only. Further reductions in contaminant levels would be expected from volatilization, adsorption, and degradation. Contaminant concentrations in groundwater and in Finley Creek, however, could increase in the future either as a result of contaminant migration from source areas or as a result of new contaminants created in degradation processes. It is possible that threats to the health of the population served by the Eagle Creek Reservoir could occur in the future.

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Table 2 (Page 1 of 3)
SUMMARY OF ECC EXPOSURE PATHWAYS
AND ASSOCIATED RISKS

Operable Unit	Exposure Pathways	Associated Risks
SOIL		
o Surface Soil	Direct contact, inhalation, and ingestion of surface contaminants. Transport of contaminants offsite as dust and runoff.	Soil cover material was not found to be contaminated before placement onsite. Contaminated ponded water on the cover indicates cover may contain contaminants. Potential exists for adverse health effects though data does not exist to quantify risk.
o Subsurface Soil	Future development onsite or erosion could result in direct contact, inhalation, and ingestion of contaminants.	If development or erosion occur, potential for adverse health effects from exposure exists. Excess lifetime cancer risks for ingestion range from 4×10^{-3} to 8×10^{-6}; however, development in close proximity to a landfill is not considered likely.
GROUNDWATER	Installation of potable well within the zone of contamination could result in direct contact, inhalation, and ingestion of contaminants.	Potential for adverse health effects from long-term exposure; several MCLs exceeded. Excess lifetime cancer risks range from 4×10^{-1} to 7×10^{-5} for ingestion of current or projected groundwater contaminants. Excess lifetime cancer risks range from 4×10^{-1} to 7×10^{-7} for dermal absorption of current or projected contaminant concentrations.

Operable Unit	Exposure Pathways	Associated Risks
GROUNDWATER (continued)	Discharge of contaminants to surface waters.	Potential for adverse health effects from ingestion of fish bioconcentrating contaminants at projected surface water concentrations. Excess lifetime cancer risk of 1×10^{-6} to 3×10^{-6}. Projected concentrations exceed WQC for protection of human health from ingestion of aquatic organisms.
		Current or projected concentrations of contaminants in surface water do not result in a threat to aquatic life as measured by ambient water quality criteria and LC_{50} values.
	Possible migration of contaminants to a deep aquifer.	Groundwater gradients are upward and this pathway is not possible.
SURFACE WATER AND SEDIMENT	Direct contact, inhalation, and ingestion of contaminants.	Excess lifetime cancer risk from dermal absorption of VOCs in surface water is less than 1×10^{-6}.

Table 2 (Page 3 of 3)

Operable Unit	Exposure Pathways	Associated Risks
SURFACE WATER AND SEDIMENT (Continued)	Transport of contaminants downstream to Eagle Creek Reservoir.	Current or projected future concentrations in surface water and sediment do not suggest a threat to human health via ingestion. Degradation products, such as vinyl chloride, however, may increase in the future and could pose a threat to human health.

Adapted from: Combined Alternatives Analysis Report: Northside Sanitary Landfill and Environmental Conservation and Chemical Corporation. December 5, 1986.

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Table 3 (Page 1 of 5)
SUMMARY OF NSL EXPOSURE PATHWAYS
AND ASSOCIATED RISKS

Operable Unit	Exposure Pathways	Associated Risks
SOIL AND LANDFILL CONTENTS		
o Landfill Surface	Direct contact, inhalation, and ingestion of surface contaminants. Transport of contaminants offsite as dust and runoff.	None. Based on a limited number of samples, the landfill surface does not appear to be contaminated.
o Landfill Contents	Future development onsite or erosion of the landfill surface could result in direct contact, inhalation, and ingestion of contaminants.	Potential exists for adverse health effects; however, development in the proximity of the landfill is highly unlikely.
o Leachate Sediment and Sediment in Old Creek Beds of Finley Creek	Direct contact, inhalation, and ingestion of contaminants. Transport of contaminants as dust and runoff.	Potential exists for adverse health effects resulting from long-term exposure to contaminants. This is based on one leachate sediment sample which contained lead and chlordane and one creek bed sediment sample which contained PCBs.

Operable Unit	Exposure Pathways	Associated Risks
LEACHATE		
o Leachate Seeps	Direct contact, inhalation, and ingestion of contaminants. Discharge of contaminants to surface waters.	Current risk to public health and environment is negligible since long-term ingestion and use of the leachate liquid is highly unlikely. However, leachate seeps represent the potential for future releases of contaminants which could result in adverse health effects for humans and adverse effects on the aquatic ecosystem in the surface waters.
o Leachate Liquid in Collection System	Direct contact, inhalation, and ingestion of contaminants.	Current risk to public health and environment is minimal since long term exposure is highly unlikely. Potential exists for contamination to increase from future releases.
o Landfill Liquid	Future development onsite could result in direct contact, inhalation, and ingestion of contaminants.	Potential exists for adverse health effects; however, development in the proximity of the landfill is highly unlikely.

Operable Unit	Exposure Pathways	Associated Risks
GROUNDWATER	Installation of a potable well within the zones of contamination could result in direct contact, inhalation, and ingestion of contaminants.	Potential for adverse health effects from long-term exposure; however, installing a potable well on or near the landfill is unlikely. Several MCLs exceeded excess lifetime cancer risk of 1×10^{-3}.
	Discharge of contaminants to surface waters.	Concentrations of organic contaminants in groundwater do not currently suggest a threat to aquatic life as measured by ambient water quality criteria and LC_{50} values.
		Concentrations of inorganic contaminants in groundwater presently exceed criteria for the protection of aquatic life.
		If contaminant types or levels in groundwater and surface water increase, adverse effects on public health and aquatic life could occur.

Operable Unit	Exposure Pathways	Associated Risks
GROUNDWATER (continued)	Possible migration of contaminants offsite.	Groundwater is believed to discharge to Finley Creek. In this case, risk to human health from offsite migration is negligible. If additional investigations indicated that groundwater is flowing under Finley Creek and to the south, the risk would be reevaluated. Concentrations of organic contaminants in surface water may constitute a risk to aquatic life during low flows.
	Possible migration of contaminants to a deep aquifer.	Based on data from ECC site investigations, the gradients are upward and this pathway is not possible.
SURFACE WATER AND SEDIMENT	Contact or assimilation of contaminants by aquatic life.	Concentrations of organic contaminants in the surface waters and sediment do not currently suggest a threat to aquatic life as measured by ambient water quality criteria and LC_{50} values. Concentrations of inorganic contaminants in surface water may constitute a risk to aquatic life during low flows.

Table 3 (Page 5 of 5)

Operable Unit	Exposure Pathways	Associated Risks
SURFACE WATER AND SEDIMENT (continued)		If contaminant types or levels in groundwater and surface water increase, adverse effects on public health and aquatic life could occur.
	Direct contact, inhalation, and ingestion of contaminants.	Concentrations of contaminants in the surface waters and sediments do not currently suggest a threat to human health. Ingestion and use of water in Finley Creek and the unnamed ditch are highly unlikely. Increases in contaminant types or levels in future could result in adverse health effects.
	Transport of contaminants downstream to Eagle Creek and Eagle Creek Reservoir, a water supply source.	Concentrations of contaminants in the surface waters and sediment do not currently suggest a threat to human health. Future release of contaminants to the surface waters may change the concentrations and risk to public health could occur.

Adapted from: Combined Alternatives Analysis Report: Northside Sanitary Landfill and Environmental Conservation and Chemical Corporation. December 5, 1986.

GLT821/23

Chapter 2
DESIGN ISSUES

This chapter describes the components of the conceptual civil engineering design planned for the combined NSL and ECC sites (NSL/ECC). The design goals identified in the ROD are presented first, followed by a description of the selected remedy and a discussion of design issues such as design criteria, design considerations, and future issues for the major design components.

GOALS

The goals for the selected remedy are presented in the ROD and are summarized as follows:

- Minimize direct contact with contaminated soil from NSL/ECC and with sediments from Finley Creek
- Minimize direct contact with leachate from seeps at the NSL site
- Control migration of contaminants from NSL/ECC to the groundwater
- Control migration of contaminants to surface water from surface erosion and leachate seeps at the combined site
- Minimize the direct consumption of contaminated groundwater
- Control migration of contaminated groundwater to surface water

Nine alternative remedies were presented in the CAA report. The alternatives were developed to provide a selection of methods meeting the goals of the remedial action. The civil engineering aspects of the selected remedy are presented below.

DESCRIPTION OF SELECTED REMEDY

The remedy selected by the U.S. EPA for NSL/ECC addresses problems with the soil and landfill contents, landfill leachate, groundwater, surface water, and sediment. This section describes the remedy as presented in the ROD for the site.

The main components of the remedy presented in the ROD include the following:

- Deed and access restrictions to prevent future development of the sites.

- A multi-layer soil-clay cap over both sites which meets RCRA requirements. The cap functions to prevent contact with the landfill waste and limits infiltration of water.

- Rerouting surface waters to reduce potential for contaminant movement to surface water. The unnamed ditch between the NSL and ECC sites will be filled with onsite borrow material and relocated west of ECC. Portions of Finley Creek will be rerouted further south to allow room for construction of a groundwater collection trench. The abandoned channels will then be filled with onsite borrow material.

- Leachate collection and treatment for the NSL site. A new leachate collection trench will be installed around the NSL site near the toe of the landfill. The trench will collect shallow leachate and leachate moving over the existing ground surface after seeping through the current landfill cover. The system will drain to a sump where the leachate will be pumped to a treatment facility.

- Groundwater collection and treatment for the combined site. A groundwater collection trench will be constructed on the south side of the NSL site between the leachate collection trench and Finley Creek. In addition, approximately 14 groundwater extraction wells will be installed on the southwest side of the ECC site. Water from those facilities will be pumped to a treatment system.

- Monitoring effectiveness of remedy components listed above. This will be discussed in future reports.

Preliminary plans illustrating the civil engineering conceptual design are included in Appendix A. These drawings are based on assumptions and preliminary design decisions. They are intended to show design concepts and the general format of the final sheets only. No design calculations have been completed in preparing these sheets. The plans are preliminary and not intended for construction.

Groundwater treatment, monitoring, and site access restrictions will be discussed in the treatment predesign report to be produced later. The remainder of this report presents the civil engineering aspects of the items identified above for design and construction. Reasons for selecting this remedy have been discussed in the Feasibility Study, CAA

Report, and ROD. Additional detail is presented herein to further develop engineering concepts. The following sections present brief overviews of the design components and how they meet the design goals.

CONCEPTUAL DESIGN

CAPPING DESIGN

Capping Design Criteria

The final cover for NSL/ECC must meet the following RCRA regulatory requirements (40 CFR 264.310).

- o It must provide long-term minimization of migration of liquids through the closed landfill.
- o It must function with a minimum of maintenance.
- o It must promote drainage and minimize erosion or abrasion of the cover.
- o It must accommodate settling and subsidence so that the cover's integrity is maintained.
- o It must have a permeability less than or equal to the permeability of any bottom liner system or natural subsoil present.

To meet these five regulatory requirements, a set of recommended RCRA guidelines has been developed that specifies that a final cover should, at a minimum, consist of the following components:

- o Vegetated top cover
- o Drainage layer
- o Low permeability hydraulic barrier layer

Detailed RCRA guidance has also been established for each component of the final cover; however, this guidance may vary on a site-specific basis. Additional design criteria which should be met at NSL/ECC include the following:

- o The hydraulic barrier layer should be wholly beneath the average depth of frost penetration.
- o The hydraulic barrier layer should be thick enough to assure integrity even if minor erosion or construction defects occur.
- o Permeable, granular layers should be designed to prevent clogging by finer grained material.

- The final cover and landfill material should be designed to remain stable after closure of the landfill.

- A gas collection system should be installed to control gas pressure under the cap.

Capping Design Considerations

Multilayered Cap. The proposed cap will cover both the NSL and ECC sites. A possible final cover for NSL/ECC is shown on Sheet C-9 in Appendix A. The final thicknesses of the various layers shown on Sheet C-9 in Appendix A are approximate and may be revised. The actual properties needed for each layer depend on precipitation, slope steepness, permeability of the topsoil layer, type of barrier layer, frost depth, and past and future uses of the area.

Vegetative Topsoil and Fill Layers. Grass will be planted over the entire landfill to reduce erosion and preserve slope stability. Use of native grasses should be explored to reduce maintenance costs. Topsoil from the borrow area and areas that will be covered by the cap will be stripped and stockpiled. If sufficient topsoil cannot be recovered from those sources, the topsoil layer's thickness may need to be reduced from the 6-inch-thick layer shown in Appendix A. Adding fertilizer or importing other topsoil could be considered as alternatives. In addition, the need for topsoil may be greatly reduced if native grasses are used.

The conceptual drawings in Appendix A show the fill layer to be 1.5 feet thick. This layer adds sufficient thickness to the total cap section to protect the clay barrier soils from freezing. The clayey borrow soil from north of the landfill is expected to be used as the fill layer material. The low permeability of this soil provides a benefit for the cap that should be considered in future iterations of the design. By placing a low permeability fill layer under the topsoil but above the sand drainage collection layer, the total seepage into the drainage layer should be low. With a low amount of seepage into the drainage layer, there will be less need for extensive drainage collection piping systems, and the effectiveness of the hydraulic barrier will be improved.

Some landfill caps are designed with layers intended to prevent intrusion of burrowing animals into the clay barrier layer, but an animal barrier layer is not planned for this site because of the estimated expense. Repair of damage caused by a burrowing animal is expected to be less expensive than constructing the animal barrier layer.

Drainage Layer. Some seepage from the topsoil and fill layers will find its way into the drainage layer. This layer is intended to allow the removal of this infiltrating water before it begins to seep through the cap or create a slope stability problem. If the water were not removed, it would eventually seep through the hydraulic barrier layer into the waste zone. Additionally, if water builds up in the cap, clay layers become saturated (heavy and weak) and the chances for slope failures are increased. The conceptual drawings show the drainage layer to be 1 foot thick, covering the entire NSL/ECC site directly over the clay barrier layer.

Slotted pipes are shown in the drawings of the cap in Appendix A. The spacing between the pipes is dependent upon the slope and permeability of the drainage and overlying fill layers. The sand material used for the drainage layer should allow water to flow freely in a lateral direction, thereby minimizing head on and flow through the low permeability layer. RCRA guidance recommends that the sand have a hydraulic conductivity of not less than 1×10^{-3} cm/s. The higher the permeability of the drainage material relative to the overlying fill, the larger the horizontal spacing between collection pipes can be. The collection pipes are expected to be spaced approximately 200 feet apart. If the pipes are not designed adequately, water may build up in the drainage layer between the pipes causing soft marshy conditions on the cap surface and higher infiltration to the waste.

Filter layers should also be addressed when considering design of a drainage layer/fill layer system. A filter layer is necessary to prevent clogging of the coarse-grained layer by migration of the overlying, fine-grained fill layer. The drainage sand particle size gradation must meet the appropriate filter requirements to prevent migration of the fill layer, or a geotextile filter material should be used. Typically, it is best if the drainage layer material meets the filter requirements because it eliminates the need for a costly geotextile layer.

Hydraulic Barrier Layer. The NSL and ECC sites do not have specially constructed underlying liners. Therefore, to prevent a "bathtub effect," the barrier layer material needs to have the same or a lower permeability than the native glacial soil beneath the sites. RCRA guidance recommends that the barrier layer be at least 2 feet thick.

Preliminary soil testing in the proposed borrow area north of NSL indicates that the borrow material should be suitable for construction of the barrier layer. The permeabilities of remolded samples from the borrow area were less than

1×10^{-6} cm/s. The actual permeability of the barrier layer after construction will depend on compaction effort, properties of the compacted material (e.g., soil type, moisture content, and homogeneity), macro structure (e.g., cracks, joints, and slides), and the contractor's methods of placing and compacting the soil.

The contractor should be required to construct a test pad where construction procedures can be closely monitored to ensure that the specified soil compaction is attained. In addition, the following construction methods may be required:

- o A sheepsfoot or padfoot compactor should be used for the cohesive material. The feet or pads should be 3 inches or longer, and the equipment weight should be appropriate for the number and size of feet or pads and the nature of the material.

- o Prior to compaction, the clay borrow material should be rototilled, scarified, or disked to break up any large soil clods and improve barrier homogeneity.

- o Lift thickness, including fluff from previous lifts after scarification, should be less than the length of the feet on the compactor so that all soil is reworked during compaction and each lift is intermixed.

<u>Gas Collection and Leachate Seep Collection Layer</u>. The proposed gas collection and leachate seep collection layer is located under the hydraulic barrier layer of the NSL portion of the cap only. The ECC site is not underlain with gas and leachate producing materials, so an extensive gas and leachate collection system is not needed. However, a limited number of vents are recommended for ECC to allow the exchange of gases from above and below.

The purpose for the NSL gas/leachate collection layer is to provide a highly permeable zone to facilitate the flow of gas and leachate to their respective collection systems. Gas collection is important to reduce the chances of high pressures developing under the cap. High gas pressure increases the chance for 1)gas migration away from the site; 2) development of fissures through the cap; and 3) fire or explosion. Leachate collection is important to reduce the chance for surface seeps and chemical damage to the barrier layer.

Design of the gas collection system should be performed by a gas system design specialist. A system of gas collection wells and collection pipes is expected because of the variety of gas producing materials within the NSL site. A thorough evaluation of gas production there should be performed to determine how to handle the collected gas (venting or flaring).

Because of its high permeability, clean gravel is well suited for this layer. Alternatively, a combined gravel/sand layer, if it meets the permeability requirements, may reduce the total material cost for this layer. A filter layer, similar to the filter between the fill and drainage layers, will be needed during and after construction. The filter will prevent clogging of the gas/leachate collection layer by the overlying clay barrier material.

Cap Limits. Cap limits were established to coincide with the leachate and groundwater collection systems around NSL and to cover contaminated soils at ECC. By constructing the cap over the areas between the refuse and the collection trenches, the amount of precipitation infiltration that would otherwise be collected in the groundwater and leachate systems is expected to be reduced.

Cap Slopes. The existing slopes on the NSL site range from 3:1 (horizontal: vertical) on the side to nearly flat on the top. Most of the sideslopes are 4:1. The ECC site is nearly flat with a slight slope to the south. The steepest design sideslopes on the landfill have been selected by the U.S. EPA and the Indiana Department of Environmental Management (IDEM) as 4:1; therefore, some filling will be necessary on portions of the landfill to meet this limit.

Slopes graded to 4:1 are expected to remain relatively stable during the design life of the cap. A flatter slope may be found to be more desirable after design calculations have been completed. However, producing flatter slopes than 4:1 would require the addition of excessive amounts of fill over the entire landfill sideslope area. With those considerations, the conceptual maximum slope remains at 4:1.

The flattest conceptual slope on the top of the landfill has been set by the U.S. EPA and IDEM at 6 percent for this project. This minimum slope will help to reduce potential ponding as the underlying refuse compresses and settles. Since the existing slope on the top of the landfill is less than 6 percent, additional material will need to be placed on top of the landfill before placement of the final cover to achieve the established minimum slope. Choice of this fill material has not yet been determined. It will depend, in part, on the expected capital costs compared to the expected operation and maintenance costs. Placement of municipal waste, for example, will not have any capital cost; however, it may increase the potential for settlement, thereby increasing operation and maintenance costs.

Placement of silty clay borrow materials, on the other hand, may help to reduce operation and maintenance costs; however, it will increase the capital costs of the material.

Settlement of the landfill surface is affected by such factors as the type and thickness of refuse, the refuse compaction method, the amount of daily cover, the time that has passed since placement, and many other factors that are not quantifiable. Therefore, the acceptable minimum slope will be based on judgment, experience, and maintenance requirements.

Where the cap will be placed over native soil rather than refuse, it will be graded to drain at slopes ranging from 2 to 10 percent. The grading plan will be coordinated with existing topography. This includes the cap over the ECC site and the zone between the toe of refuse and the leachate and groundwater collection trenches at the landfill. Several mounds of soil and low ditches exist in the areas not associated with refuse. The high spots will be graded off and the low spots filled in as part of the site grading.

Borrow Area. The area north and northeast of the NSL site has been investigated and identified as an acceptable borrow pit for this project. Investigations have indicated that material in this area will be suitable for use as clay barrier and fill material. In addition, it is anticipated that topsoil will also be collected from this borrow area. Conceptual drawings in Appendix A (Sheets C-1, C-2, and C-3) show the conceptual contours for the borrow area at the end of construction. Borrow area design will consider stability of sideslopes and incorporate final drainage patterns that are similar to those that currently exist in the area.

Future Issues

Conceptual design has been based on estimates, experience, judgment, and minor analysis. Assumptions made must be checked. In addition to checking assumptions made for the conceptual design, the following areas should be addressed in the final design:

- Erosion control (temporary and permanent)
- Cap material placement specifications
- Analysis and design of the drainage collection system including design of the collection pipe system
- Sources/types of filters/drainage materials

- Material properties necessary to meet design needs such as permeabilities and filter criteria

- Slope stability analysis of the refuse and overlying cap layers

- Settlement monitoring program

- Materials balance between the borrow area and cap material needs

- Site grading and cap limits

As design of the cap progresses and the different analyses are completed, the items described above can be expected to change.

GAS CONTROL SYSTEM

Design Criteria

Municipal waste landfills contain a large amount of organic material. When this material begins to decompose, methane gas and other gases are produced. Currently at the NSL site, this gas is able to dissipate by seeping out of the refuse through the thin cover. Placing a cap over the landfill with a low permeability hydraulic barrier layer will block gas from seeping out. If the gas cannot leave the landfill, it will collect under the cap and cause problems. The following problems could develop because of collecting landfill gas:

- High gas pressures may develop and produce cracks in the barrier layer and soil cover. Leakage into the landfill through a crack would cause higher leachate production.

- If gas concentrations under the cap increase to levels exceeding the explosive limit, an explosion or fire could develop.

- High gas pressure under the cap could cause gas to migrate through the ground to an adjacent structure. The gas might collect in the structure and create a fire, explosion, or other health hazard.

Gas control systems are installed in landfills to prevent high gas pressure from developing. Gas control systems use either active or passive gas collection methods. Active gas collection systems use a blower to develop suction and draw gas from the landfill. Passive gas collection systems use the pressure gradients within the refuse to produce flow of gas into the collection wells or trenches; as pressures build up, a pressure gradient develops and the gas flows from the high pressure area to the low pressure collection well or trench.

The decision to use active or passive collection depends upon the rate at which gas is being produced and the desired method of gas disposal. Active systems are useful if:

- Gas production is so high that passive pressure systems are not effective in reducing pressures
- The gas is being collected at one location for purification and use as a fuel
- The gas is being collection at one location for burning in a flare
- A gas migration problem is present and flow of gas away from the landfill must be controlled.

Passive systems typically vent the gas to a flare for direct burning or to the atmosphere without burning. Large landfills usually need an active gas collection system for final closure because of high gas production rates.

Gas control systems use vertical wells or slotted pipes placed in gravel-filled trenches to collect the gas. The type of collection system used (trench or well) varies depending upon many factors including the type, age, and thickness of the refuse. Typically, gas collection trenches are not used as the main collection system if refuse is more than 60 feet thick. However, the trenches are effective at removing gas directly below the cap.

Gas collection wells are installed by drilling a 24- to 36-inch diameter boring through the refuse. A slotted well casing is placed in the boring, and the annular space between the well screen and boring wall is backfilled with clean washed gravel. Gas collection wells are often spaced 150 to 200 apart. Gas collection trenches are excavated into the refuse surface, a slotted pipe is placed, and the trench is backfilled with washed, clean gravel. Spacing between trenches varies from 100 to 400 feet, depending upon conditions at the landfill.

Landfill gas is usually warm and full of moisture. When the gas enters the collection system, it cools and the moisture condenses on the wall of the pipe to form a liquid called condensate. Condensate will form continuously within the gas collection system, so it must be drained to keep the system open. Condensate is typically considered hazardous and must be treated as such when disposal options are being considered. Some landfills drain the condensate into the refuse while others collect the condensate and remove it from the landfill for treatment and disposal.

Monitoring and control of municipal landfill gas is required under Subtitle D regulations as part of 40 CFR Parts 257 and 258. The U.S. EPA is currently in the process of revising the requirements with proposed regulations available for public comment. The current and proposed regulations should be reviewed to determine which apply. Regulations within Part 257 and proposed Part 258 for gas control limit the concentrations of methane that can be escaping from the landfill based on percentages of the explosive limit (concentration above which an explosion could occur).

Monitoring and control of gas from the NSL site should also be developed based upon the allowable concentrations for volatiles released to the air.

Design Issues

The following conceptual design has been developed based upon the information available at this time. It must be reviewed and revised as necessary to operate effectively and meet the regulations. Approximate design details are shown on the drawings.

- Assume that a passive gas collection/vent system will be adequate. The gas collection system should be designed so it can be modified to use flares or be an active system if necessary.

- Use vertical gas collection wells spaced approximately 200 feet apart in portions of the refuse thicker than 40 to 60 feet.

- Cover the landfill with a gas collection layer directly under the hydraulic barrier layer to allow collection of gas that builds up directly below the barrier layer.

- Use gas collection trenches to collect gas from the collection layer. Space trenches 200 to 400 feet apart.

- Condensate that is collected in the system should be drained to the leachate collection pipe and treated along with leachate.

- Install gas monitoring wells as appropriate around the site based upon site conditions and requirements in Subtitle D Part 257 of 40 CFR. It is expected that there will be at least three gas monitoring wells around the property perimeter as well as monitoring of gas concentrations in structures and in the air on and off the site.

Future Issues

As part of design, the approximate amount and type of refuse placed in the landfill each year should be estimated and used for predicting gas generation curves. The gas generation curves are used in deciding whether or not an active gas collection system is necessary. With this information, analysis and design should be completed for the gas control system.

LEACHATE COLLECTION TRENCH DESIGN

Design Criteria

The leachate collection trench is required to intercept leachate moving within the upper 4 feet of soil just outside the NSL refuse zone. The goal is to have all of the intercepted liquid flow to a sump from which it can be pumped and subsequently treated. Design criteria for the leachate collection trench include the following items:

- Liquids within the system should flow by gravity to the sump to keep power requirements low.
- The pipe invert should be approximately 4 feet below the ground surface.
- The collection system should be continuous around the outside edge of the NSL site.
- Pipes should be designed so they can be inspected and cleaned easily during site maintenance.
- The collection trench system should connect with the gas/leachate seep collection layer over the landfill surface to facilitate collection and treatment of leachate seeping from the landfill surface slopes.

The drawings in Appendix A show plans and profiles of the conceptual leachate collection trench.

Design Considerations

The leachate collection system is intended to intercept leachate seeping through the near surface soils just outside of the refuse zone of the NSL site. By intercepting the water at that point, it is hoped that the groundwater in the immediate area can be protected from future contamination. The leachate collection trench is not intended to remove contamination from the soil outside the proposed trench. The need for this system is expected to decrease with time after the cap has been constructed because the amount of leachate is expected to decrease.

A gravel-filled trench will be installed to ring the site just outside the refuse limits as shown on the conceptual plans in Appendix A. Leachate is expected to seep into the gravel-filled trench and be collected by a slotted pipe. Since the water will flow through the pipe more easily than through soil, the raw leachate should flow in the pipe to the collection sump. A depth of 4 feet has been selected as the approximate pipe depth for the leachate collection pipe.

The leachate collection system will also be used to collect leachate that is seeping from the surface slopes of the landfill. Leachate seeping from the landfill surface will enter the leachate collection layer and flow through the gravel layer to the leachate collection trench. Once in the trench, the leachate should flow to the collection sump for removal and treatment. The conceptual drawings show that the leachate collection layer gravel is expected to extend over the leachate collection trench, allowing the surface seepage to flow into the collection trench as it crosses it. A layer of geotextile will be placed between the trench sides and the backfill to act as a filter and help prevent the plugging of the system with soil.

Collection pipe diameter is expected to vary with location in the system depending upon the volume of water to be carried. Maximum flow rates for this system are expected to be low: less than 150 gpm for the entire system based upon estimates made during the RI/FS. Pipes closer to the sump will be handling all of the flow from upstream in the system and will therefore be larger in diameter. For illustrative purposes, the leachate collection trench profile in Appendix A shows pipe sizes varying from 6 to 10 inches in diameter and a slope that nearly parallels the ground surface. The pipe diameters and slopes shown have not been based on design calculations.

The conceptual drawings also show typical manhole and sump details. Manholes are spaced at approximately 300 to 400 feet to allow general cleanout and maintenance of the system. Since the cap will extend over the leachate collection system, the manholes will need to be tall enough to extend up to the final cap surface. The manholes are shown to have a large diameter to allow access to a worker wearing an air tank and face mask for breathing protection. The sump shown uses precast concrete sections. The precast concrete is preferred to protect against uplift since it is significantly heavier than alternatives such as a fiberglass or high density polyethylene preformed sump/tank.

Future Issues

Design of the leachate collection system is important to this project because failure of the system would necessitate disturbing the cap. No analysis or design has been performed in developing the conceptual plan. During the design phase, the following issues must be addressed:

- Flow rates into the system per foot of trench must be estimated accurately enough to provide a basis for pipe sizing.

- Based upon the estimated flow rate and convenient or appropriate pipe slopes, the pipe sizes and the actual spacing between manholes must be selected.

- The issue of microbiological clogging and mineral precipitate clogging of the pipe slots must be addressed so that the pipe remains free-draining. Clogging by precipitates is a particular problem that must be addressed in design because the pipe will generally be above the groundwater table and may be subject to wetting and drying.

- The pipe slot size must be selected to be compatible with the gravel or sand available for use in the trench so soil particles do not migrate into the pipe. Conversely, the slot sizes must also be large enough to prevent plugging by the backfill and precipitate.

- The depth of storage in the sump and the pump size will require design based upon the estimated inflow rates and the pump cycling time. Liquids removed from the sump are expected to be pumped to a flow equalization tank to ensure a constant flow of water to the treatment system.

GROUNDWATER COLLECTION SYSTEM DESIGN

Design Criteria

The groundwater collection system is proposed to perform both as a collection system and as a hydraulic barrier between the contaminated groundwater that is present south of the NSL and ECC sites and uncontaminated groundwater off-site. Groundwater above the 25-foot depth is to be intercepted and collected and then combined with the water collected in the leachate interceptor trench for treatment. The system is proposed to include a collection trench and extraction wells. Design criteria include:

- As much of the system as possible should drain by gravity to the sump.

- Groundwater interception and collection must be continuous along the south side of the NSL site and should provide maximum water interception in the sand layer south and west of the ECC site.

- The system should be designed to minimize the amount of uncontaminated water that is collected.

- The system should function continuously with a minimum amount of maintenance.

Design Considerations

Subsurface conditions along the alignment are expected to be variable. Borings performed during a recent investigation indicate that a fractured glacial till is present through the full depth of the proposed trench from the east end to a point just south of the ECC site. At this location, a deep pocket of sand has been identified. One boring into this area indicates that the sand is at least 35 feet deep there.

The glacial till zone is not expected to produce large volumes of water, so the gravel and pipe filled trench concept used in the leachate collection system is applicable. However, the area underlain by the deep sand deposit is expected to produce large quantities of water when dewatered. In this area, a series of approximately 14 wells with submersible pumps may be more appropriate. It may also be appropriate to construct a bentonite slurry cutoff wall to limit the area influenced by the pumping and to reduce the pump discharge.

The conceptual drawings show a proposed profile for the collection trench system. At this time, the pipe system is sloped to flow from east to west at approximately 1/2 percent. The pipe invert is to be located approximately 25 feet below the ground surface. Manholes are spaced at 300- to 400-foot intervals to allow cleaning of the system and are sized to allow access to a worker wearing an air tank and face mask.

To limit infiltration of clean water into the system, two steps are proposed:

- The area between the refuse and the groundwater trench should be covered with the cap.

- A hydraulic barrier on the south side of the collection trench should be installed during construction.

Extending the cap will limit the amount of surface infiltration that can occur. By lining the south side of the collection trench with a barrier material (PVC membrane, bentonite blanket, or compacted clay wall), infiltration of water from south of the system will be reduced. The conceptual drawings and the cost estimate assume that a bentonite blanket will be draped over the side of the excavated area during backfill.

As with the leachate collection trench, the collection gravel should be coarse and clean of fines to allow easy flow of water to the pipe. The use of coarse gravel will require the use of a geotextile filter on the north side of the leachate collection trench so that fine soil particles do not migrate into the trench backfill.

Future Issues

The following issues must be addressed during future design efforts if the cap is to function as designed for 30 years:

- Pipe sizes and slopes must be designed to match the estimated flow rates for the section of the collection system passing through the glacial till.
- The collection system geotextile filter, gravel, and pipe slot size will require sizing to make the different components compatible with each other.
- The actual method for restricting flow from entering the south side of the collection trench must be finalized. Several different factors, including the trench excavation methods, will have an impact on the effectiveness and constructibility of the various methods available.
- The spacing, number, and depth of extraction wells in the sand zone near the ECC site must be selected. A hydraulic conductivity test is proposed to provide data about the aquifer for use in designing those details.
- The hydraulic conductivity test results should also provide some information that will help determine the need and usefulness of designing and installing a slurry cutoff wall outside the well system.
- Design of the sump for the collection trench must be based on flow rate estimates and discharge pump systems and cycle times that will be used.

DITCH/CREEK REALIGNMENT

Design Criteria

Portions of Finley Creek and the unnamed ditch will be realigned. Finley Creek will be rerouted further to the south to provide more space between the creek bed and the groundwater collection system and to reduce the potential for surface water contamination. The unnamed ditch will be rerouted to the west of the ECC site to allow construction of the cap over the area between the NSL and ECC sites that is now part of the ditch. The unnamed ditch will be placed in a culvert because a ditch deep and wide enough to maintain the channel slope necessary for water flow would not fit in the space available between residences and the highway. A ditch would also be more difficult to maintain than a culvert.

Design Considerations

Preliminary hydrologic analysis has been performed for Finley Creek. A typical cross section for the new segments of Finley Creek has been established by measuring existing cross sections along Finley Creek in the area to be realigned. This typical section has a bottom width of 12 feet, 4:1 (horizontal:vertical) sideslopes, and a 3.5-foot channel depth. If slope changes resulting from pool and riffle stream configurations are neglected, flow capacities ranging from 250 cubic feet/second (cfs) to 370 cfs can be anticipated for various typical sections (Table 4).

Table 4
EXISTING CAPACITY OF FINLEY CREEK

Location	Slope ft/ft	Capacity cfs
Upstream of Hwy 421	0.0052	370
South of the NSL site	0.0045	350
SE corner of NSL site	0.0023	250

Peak flow estimates near the cross of Hwy 421 for 1-, 10-, and 100-year recurrence interval storms are 310 cfs, 770 cfs, and 1,300 cfs, respectively. A comparison between these peak flows and the capacities shows that the channels can currently handle the 1-year recurrence interval storm.

The conceptual drawings in Appendix A show that the proposed realignment puts Finley Creek on the south side of the existing flood plain.

The flow currently passing through the unnamed ditch will be intercepted in a closed conduit located at the northwest corner of the ECC site. This conduit will convey water by gravity along the alignment shown in the conceptual drawings to the point where Finley Creek crosses under Hwy 421. The 1-, 10-, and 100-year recurrence interval peak flows have been estimated for this conduit based on the available watershed information. These peak flows are presented with the associated pipe size necessary to handle the flow for the slope available between the inlet and outlet points on the conduit (Table 5).

Table 5
PEAK FLOW VERSUS CONDUIT SIZE
UNNAMED DITCH

Recurrence Interval	Peak Flow (cfs)	Unnamed Ditch Pipe Size (inches)
1 year	120	48
10 year	290	72 or 2 x 60
100 year	530	96 or 3 x 60

A storage basin may be used to accumulate the flow during peak storms so it may be released over a long period of time in controlled amounts. This would reduce the size of the pipe required for ditch relocation. With a storage basin constructed in the area currently used as a borrow area north of the NSL site, the discharge could be limited to 120 cfs, which is approximately the 1-year storm peak flow. To provide the 120 cfs discharge (48-inch pipe), the following storage requirements are necessary.

Table 6
STORAGE BASIN SIZES TO ALLOW 120 CFS DISCHARGE FROM SITE

Recurrence Interval	Storage Volume (acre-feet)
1 year	0
10 year	15
100 year	30

Future Issues

During design, the channels for Finley Creek and the unnamed ditch conduit/storage basin systems need to be sized. The current stream and ditch sections appear to be sized to handle the 1-year recurrence interval event, but the recurrence interval for which the channels are designed needs to be considered. It is not known where the flood waters will go when the stream floods during the longer recurrence interval storms. Part of the toe of the landfill cap may be constructed within the flood plain. It should be determined whether the cap requires some form of armoring as extra protection against damage by flood waters. The design should accommodate a flow path for stormwater produced by storms that exceed the selected design criteria of Finley Creek and the unnamed ditch. The design should also determine if it is necessary to provide for flood plain storage to compensate for what is removed by the construction of the landfill cap.

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Chapter 3
IMPLEMENTATION ISSUES

PERMITS AND REGULATORY REQUIREMENTS

Applicable laws, regulations, policies, and criteria are discussed in the FS report. The designers must identify final permitting and regulatory requirements.

ACCESS, EASEMENTS, AND RIGHTS-OF-WAY

The design team must determine the access requirements (rights of entry for construction) as part of the detailed design. Rights-of-way and easements may also be required for utilities or access routes through adjoining properties in addition to right-of-way agreements for realignment of Finley Creek and the unnamed ditch.

QUALITY ASSURANCE AND SITE SAMPLING PLAN

If sampling is required for additional information during design and construction, a site-specific Quality Assurance Project Plan and a Site Sampling Plan will be prepared. They are required for any sampling for design and for sampling during project implementation.

HEALTH AND SAFETY REQUIREMENTS

Onsite safety concerns are mainly related to the operation of heavy equipment and the potential for worker contact with contaminants during excavation. The hazards of groundwater extraction result mainly from possible contact with contaminated groundwater. Normal, prudent safety procedures for workers at hazardous waste sites should be sufficient to protect against such hazards.

Health and safety are issues for local residents. A perimeter air monitoring program should be established to record local dust conditions and any possible releases of contaminated dust during excavation. It may be necessary to monitor for volatile organic compounds in the air. An emergency response plan should be defined and should include action levels and local contacts.

Offsite safety concerns are mainly related to the transportation of contaminated materials over public highways. Routing trucks to avoid populated areas will minimize the potential for accidental public exposure. The emergency response plan should address accidental offsite spills.

The contaminated soil and gas produced by the landfill present potential health hazards to construction workers at the site. Each specific activity and associated work function will require the definition and enforcement of specific safety precautions and levels of protection. Ambient air monitoring should be performed, and all workers must use appropriate levels of protection. In addition to personal protection, the safety plan should specify site entry procedures, confined space entry procedures for sampling in ditches and buildings, decontamination procedures, work limitations, and material disposal requirements. A detailed health and safety plan will be prepared and incorporated into the bid documents as part of the site work requirements.

COMMUNITY RELATIONS ACTIVITIES

A detailed community relations plan, developed during final design, will provide updates of progress made at the site. The U.S. EPA and the Indiana Department of Environmental Management have provided community relations efforts throughout the RI/FS and will likely continue to do so during implementation of the remedy. The designers may be requested to support the effort.

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Chapter 4
COST ESTIMATE

INTRODUCTION

The costs presented in this report are intended to be estimates of total resource costs for the civil engineering components of the remedial action alternative. They represent a refinement of the FS cost estimate because they reflect design modifications made since the FS. The civil engineering cost estimate was prepared from cost information in the 1988 Means Site Work Costs Data guide and the 1986 Means Site Work Cost Data guide (adjusted for 1988), estimates for similar projects, and estimates provided by equipment vendors. Specific changes to the FS cost estimates include:

- Addition or deletion of individual construction tasks
- Changing of material quantity requirements
- Refining the unit prices of costly materials by obtaining unit costs from local suppliers and contractors
- Refining the remaining unit prices by applying an inflation factor of 4 percent per year to the FS cost estimates

Results of the detailed cost estimates are shown in Tables 7 through 10. The civil engineering direct capital cost estimate has a +30 to -15 percent accuracy. The direct capital cost estimate for groundwater and leachate treatment facilities and the operations and maintenance cost estimate remain at an order-of-magnitude level of accuracy; that is, the cost estimates have an accuracy of +50 to -30 percent. The present worth of the remedial alternative was calculated assuming 3, 5, and 10 percent discount rates and a 30-year life.

The predesign cost estimates were prepared from information available at the time the estimate was made. Final cost of the remedy will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final project schedule, continuity of personnel, engineering between the predesign and final design, and other variable factors. As a result, the final costs will vary from the estimates presented in this report.

ASSUMPTIONS

Total capital costs are expenditures required to initiate and install a remedial action. Both direct and indirect costs are considered in the development of capital cost estimates. Direct costs include construction costs and expenditures for equipment, labor, and materials required to complete a remedial action. Indirect costs consist of engineering, permitting, supervising, and other services necessary to carry out action.

Because the predesign is conceptual and based on available data, bid and scope contingencies were estimated to account for reasonable anticipated yet unknown costs. Bid contingencies account for factors that might increase costs associated with construction such as the economic/bidding climate, the contractor's level of experience in working on hazardous waste sites, the contractor's uncertainty regarding liability and insurance on hazardous waste sites, adverse weather conditions, strikes by material suppliers, and geotechnical unknowns. Scope contingencies cover changes that invariably occur during final design and implementation. Scope contingencies include provisions for such items as inherent uncertainties in defining waste volumes and regulatory or policy changes that may affect FS assumptions. Allowances for inflation and abnormal technical difficulties are not accounted for in the contingencies.

Level C and Level D personal protective equipment are expected to be necessary to meet health and safety requirements. All vehicles that have direct contact with contaminated soil and landfill wastes during construction must be decontaminated. During demobilization, the vehicles and hand equipment used onsite will be steam cleaned. Workers exposed to contaminated soil during onsite activities will receive physical examinations before and after all phases of activity involving worker exposure to contaminated elements at the site. These health and safety measures are addressed in a supervision/health and safety contingency designed to include costs incurred for work on hazardous waste sites above and beyond those incurred on conventional construction jobs.

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TABLE 7

NSL/ECC CIVIL ENGINEERING PREDESIGN CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST	ASSUMPTIONS	REFERENCE
DIRECT CAPITAL COSTS						
1. SITE PREPARATION						
FILL IN DUCK POND						
PUMP OUT WATER	25	DAYS	105	2,625	THE POND IS NOT HYDRAULICALLY CONNECTED TO THE SAND	MEANS 21-404-0650
BACKFILL	11900	CY	9	107,100	THE POND WATER CAN BE DISCHARGED DIRECTLY INTO	LOCAL GRAVEL PITS, MEANS (2)
					FINLEY CREEK	12.1-722-1800 & 12.1-220-6050
REMOVE ECC PROCESS BUILDING						
BUILDING REMOVAL	108750	CF	0.2	21,750	SINGLE BUILDING, NO SALVAGE	MEANS (2) 2.1-250-0300
DISPOSAL - DUMP CHARGE	360	CY	4.2	1,512	DEMOLISHED BUILDING VOLUME, DUMP AT SANITARY LANDFILL	MEANS (2) 2.1-320-0100
CLEARING AND GRUBBING						
BORROW AREA	12.5	ACRES	2200	27,500	LIGHT WOODS	MEANS 21-104-0100
NSL	4.5	ACRES	7200	32,400	HEAVY WOODS	MEANS 21-104-0300
ECC	1.5	ACRES	7200	10,800	HEAVY WOODS	MEANS 21-104-0300
SUBTOTAL				$204,000		
2. FINLEY CREEK						
CLEAR AND GRUB	1	ACRE	7200	7,200	HEAVY WOODS	MEANS 21-104-0300
EXCAVATE NEW CREEK BED	6700	CY	4.4	29,480		MEANS 12.1-416-2100
FILL OLD CREEK BEDS	9300	CY	2.3	21,390	USE EXCAVATED MATERIAL - NEW CREEK BED, ONSITE BORROW	MEANS 12.1-726-1800
SLOPE PROTECTION	1300	CY	13.1	17,030	IMPORTED GRAVEL	UNIT PRICE REFLECTS AVERAGE OF
ESTABLISH VEGETATION COVER						LOCAL GRAVEL PITS
SOIL (4" TOPSOIL)	3444	SY	2	6,888	0.3'-THICK TOPSOIL	MEANS (1) 022-286-0700
HYDROSEED	31000	SF	0.04	1,240	FESCUE, HYDRAULIC SPREADER	MEANS 29-308-2700
SUBTOTAL				$83,000		
3. UNNAMED DITCH						
EXCAVATE FOR 60" DRAW PIPE	4500	CY	4.4	19,800	6'-WIDE DITCH	MEANS 12.1-416-2100
PIPE/BACKFILL	1150	LF	125	143,750	PRECAST CONCRETE, 5' ID	MEANS 27-162-2090
MANHOLES	4	EA	3300	13,200	PRECAST CONCRETE, 5' ID, 14' AVERAGE DEPTH	MEANS 12.3-710-6100
HEADWALL	1	EA	3200	3,200		MEANS 12.3-750-2100
SUBTOTAL				$180,000		
4. MONITORING PROGRAM						
MONITORING WELLS						
11 - UPPER GLACIAL TILL	320	LF	60	19,200	SHALLOW - HOLLOW STEM AUGER	FEASIBILITY STUDY
13 - MID-DEPTH	490	LF	60	29,400	SHALLOW - HOLLOW STEM AUGER	FEASIBILITY STUDY

NSL/ECC CIVIL ENGINEERING PREDESIGN CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST	ASSUMPTIONS	REFERENCE
DIRECT CAPITAL COSTS						
2 - DEEP SAND AND GRAVEL	350	LF	75	26,250	DEEP, DOUBLE CASING, TILL WELL ADJACENT TO N. DEEP WELL	FEASIBILITY STUDY
PIEZOMETERS						
2 - UPPER GLACIAL TILL	40	LF	60	2,400	SHALLOW - HOLLOW STEM AUGER	FEASIBILITY STUDY
2 - MID-DEPTH	70	LF	60	4,200	SHALLOW - HOLLOW STEM AUGER	
SUBTOTAL				$81,000		
5. NSL CAP CONSTRUCTION						
PRELIMINARY GRADING						
1. CLAY FILL - SCRAPING, HAULING,						
PLACING, COMPACTING OR	204000	CY	7.2	1,468,800	6% CROWN, PLACEMENT OF SILTY CLAY BORROW MATERIAL	MEANS 12.1-220-6050
2 MUNICIPAL WASTE - SCRAPING,						
HAULING, PLACING, COMPACTING	87000	CY	7.2	626,400	6% CROWN, PLACEMENT OF MUNICIPAL WASTE, THIN SOIL LAYER	
LEACHATE/GAS COLLECTION SYSTEM						
GRAVEL SUPPLIED TO SITE	90300	CY	13.1	1,182,930	1' IMPORTED GRAVEL COVERS 56-ACRE LANDFILL AREA ONLY	UNIT PRICE REFLECTS AVERAGE OF
					MATERIAL WILL NOT REQUIRE REHANDLING	LOCAL GRAVEL PITS
GRAVEL PLACEMENT AND COMPACTION	90300	CY	2.2	198,660		MEANS 12.1-722-1800
VENTING WELLS	4200	LF	65	273,000	61 WELLS AT 200' SPACING	ATEC ASSOCIATES
GAS COLLECTION TRENCH	3500	LF	4.4	15,400	2' WIDE X 2' DEEP TRENCH @ BREAK IN SLOPE	MEANS (2) 12.3-110-1310, ADS INC
GEOTEXTILE	271000	SY	1.4	379,400	1 LAYER COVERS 56-ACRE LANDFILL AREA ONLY	D. J. MORIVA CO.
BARRIER LAYER						
SCRAPING , HAULING, PLACING,						
COMPACTING	219400	CY	7.2	1,579,680	2' ONSITE BORROW MATERIAL COVERS 68-ACRE NSL SITE	MEANS 12.1-220-6050
DRAINAGE LAYER						
SAND - SUPPLIED TO SITE	109700	CY	7.8	855,660	1' IMPORTED SAND COVERS 68-ACRE NSL SITE	UNIT PRICE REFLECTS AVERAGE OF
SAND - PLACEMENT AND COMPACTION	109700	CY	3.3	362,010		LOCAL GRAVEL PITS
GEOTEXTILE	329000	SY	1.4	460,600	1 LAYER COVERS 68-ACRE NSL SITE	D. J. MORIVA CO.
FILL LAYER						
SCRAPING, HAULING, PLACING						
COMPACTING	164600	CY	7.2	1,185,120	1.5' ONSITE BORROW MATERIAL COVERS 68-ACRE NSL SITE	MEANS 12.1-220-6050
ESTABLISH VEGATATIVE COVER						
SOIL					0.5' ONSITE SOIL COVERS 68-ACRE NSL SITE	
EXCAVATION THROUGH COMPACTION	54900	CY	10.3	565,470		MEANS(1) 022-286-0150,
FINAL GRADING	329000	SY	0.6	197,400	FINE GRADE	MEANS (2) 2.3-220-2100
VEGETATION						
HYDROSEED	2962000	SF	0.04	118,480	FESCUE, HYDRAULIC SPREADER	MEANS 29-308-2700
OPTION 1 SUBTOTAL				$8,843,000		
OPTION 2 SUBTOTAL				$8,000,000		

NSL/ECC CIVIL ENGINEERING PREDESIGN CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST		ASSUMPTIONS	REFERENCE
DIRECT CAPITAL COSTS							
6 ECC CAP CONSTRUCTION							
PRELIMINARY GRADING							
SCRAPING, HAULING, PLACING,							
COMPACTING	15000	CY	7.2	108,000			MEANS 12.1-220-6050
BARRIER LAYER							
SCRAPING, HAULING, PLACING,							
COMPACTING	29000	CY	7.2	208,800		2' ONSITE BORROW MATERIAL COVERS 9-ACRE ECC SITE	MEANS 12.1-220-6050
DRAINAGE LAYER							
SAND - SUPPLIED TO SITE	14500	CY	7.8	113,100		1' IMPORTED SAND COVERS 9-ACRE ECC SITE	UNIT PRICE REFLECTS AVERAGE OF
SAND - PLACEMENT AND COMPACTION	14500	CY	3.3	47,850			LOCAL GRAVEL PITS
GEOTEXTILE	43600	SY	1.4	61,040		1 LAYER COVERS 9-ACRE ECC SITE	D. J. MORIVA CO.
FILL LAYER							
SCRAPING, HAULING, PLACING,							
COMPACTING	21800	CY	7.2	156,960		1.5' ONSITE BORROW MATERIAL COVERS 9-ACRE ECC SITE	MEANS 12.1-220-6050
ESTABLISH VEGETATIVE COVER							
SOIL							
EXCAVATE THROUGH COMPACTION	7300	CY	10.3	75,190		0.5' ONSITE SOIL COVERS 9-ACRE ECC SITE	MEANS (1) 022-286-0150,
FINAL GRADING	7300	CY	0.6	4,380			MEANS (2) 2.3-220-2100
VEGETATION							
HYDROSEED	392000	SF	0.04	15,680		FESCUE, HYDRAULIC SPREADER	MEANS 29-308-2700
SUBTOTAL					$791,000		
7. LEACHATE COLLECTION SYSTEM							
EXCAVATE TRENCH & BACKFILL LABOR	5910	LF	8.2	48,462		2' WIDE, AVERAGE DEPTH - 6'	MEANS 12.3-110-1840
LINE TRENCH							
GEOTEXTILE	83000	SF	0.16	13,280			D. J. MORIVA CO.
PERFORATED PIPE	5910	LF					
4"	2060	LF	2	4,120			ADS INC.
6"	3850	LF	2.7	10,395			ADS INC.
GRAVEL BACKFILL	2200	CY	13.1	28,820			UNIT PRICE REFLECTS AVERAGE OF
							LOCAL GRAVEL PITS
SUMP/PUMP STATION	1	EA	5000	5,000		SUMP, INCLUDES PUMP (SIMPLEX) AND CONTROLS	FEASIBILITY STUDY
MANHOLES	21	EA	1830	38,430		PRECAST CONCRETE, 4'ID, 10' DEEP	MEANS 12.3-710-5880
SUBTOTAL					$149,000		

NSL/ECC CIVIL ENGINEERING PREDESIGN CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE		TOTAL COST	ASSUMPTIONS	REFERENCE
DIRECT CAPITAL COSTS							
8. GROUNDWATER INTERCEPTION AND COLLECTION							
TRENCH							
EXCAVATION	2500	LF	19.1	47,750		20' DEEP X 4' WIDE	MEANS 12.3-110-1400,1480
SHORING AND BRACING	50000	SF	2.8	140,000		20' DEEP X 4' WIDE X 2500' LONG	MEANS (2) 2.3-420-5200,5250
DEWATERING	4	EA	665	2,660		SUMP PUMPS	FEASIBILITY STUDY
LINE TRENCH							
IMPERVIOUS MEMBRANE	62000	SF	1	62,000		BENTONITE MATTING OR PVC GEOMEMBRANE	FEASIBILITY STUDY
PERVIOUS GEOTEXTILE	75000	SF	0.16	12,000			D. J. MORIVA
DEWATERING WELLS	4	EA	7000	28,000		6" STAINLESS STEEL, 20' SCREEN, 30 GPM PUMP	MASON COUNTY FS
PERFORATED PIPE							
10"	1000	LF	2	2,000		FLEXIBLE PLASTIC PIPE	ADS INC.
8"	900	LF	1.05	945		FLEXIBLE PLASTIC PIPE	ADS INC.
6"	600	LF	0.6	360		FLEXIBLE PLASTIC PIPE	ADS INC.
GRAVEL BACKFILL	7400	CY	13.1	96,940			UNIT PRICE REFLECTS AVERAGE OF LOCAL GRAVEL PITS
SUMP/PUMP STATION	1	EA	12000	12,000		SUMP, INCLUDES PUMP (SIMPLEX) AND CONTROLS	SIMPLEX
MANHOLES	9	EA	6550	58,950		PRECAST CONCRETE 5' ID, MEANS PRICE DOUBLED FOR INCREASED DEPTH OF MANHOLE	MEANS 12.3-710-6100
SUBTOTAL					$464,000		
9. ACCESS RESTRICTIONS							
FENCING	9300	LF	13.1	121,830		6' CHAIN LINK WITH BARBED WIRE	FEASIBILITY STUDY
GATE	2	EA	2200	4,400			FEASIBILITY STUDY
SIGNAGE	62	EA	36	2,232		1 SIGN EVERY 150 FT. ALONG FENCE	FEASIBILITY STUDY
SUBTOTAL					$128,000		
OPTION 1 CONSTRUCTION SUBTOTAL					$10,923,000		
OPTION 2 CONSTRUCTION SUBTOTAL					$10,080,000		
10. CONTINGENCIES							
MOBILIZATION/DEMOBILIZATION (5%)				546,150			
HEALTH AND SAFETY (15%)				1,638,450			
BID CONTINGENCIES (15%)				1,638,450			
SCOPE CONTINGENCIES (25%)				2,730,750			
OPTION 1 CONSTRUCTION TOTAL					$17,477,000		

NSL/ECC CIVIL ENGINEERING PREDESIGN CAPITAL COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE		TOTAL COST	ASSUMPTIONS	REFERENCE
DIRECT CAPITAL COSTS							
MOBILIZATION/DEMOBILIZATION (5%)				504,000			
HEALTH AND SAFETY (15%)				1,512,000			
BID CONTINGENCIES (15%)				1,512,000			
SCOPE CONTINGENCIES (25%)				2,520,000			
OPTION 2 CONSTRUCTION TOTAL					$16,128,000		
11. OTHER							
PERMITTING (5%)				873,850			
SERVICES DURING CONSTRUCTION				350,000			
OPTION 1 TOTAL IMPLEMENTATION COST					$18,701,000		
PERMITTING (5%)				806,400			
SERVICES DURING CONSTRUCTION				350,000			
OPTION 2 TOTAL IMPLEMENTATION COST					$17,284,000		
12. ENGINEERING							
ENGINEERING DESIGN COST				400,000			
OPTION 1 CIVIL ENGINEERING CAPITAL COST					$19,101,000		
OPTION 2 CIVIL ENGINEERING CAPITAL COST					$17,684,000		
TREATMENT CAPITAL COST					$3,045,000		CAA
OPTION 1 TOTAL CAPITAL COST					$22,146,000		
OPTION 2 TOTAL CAPITAL COST					$20,729,000		

NOTE: TREATMENT CAPITAL COSTS INCLUDED IN THIS ESTIMATE REFLECT THOSE USED IN THE CAA DATED 12/5/86 AND HAVE A CONFIDENCE OF +50 -30.
CAPITAL COSTS WERE CALCULATED FOR TWO OPTIONS FOR THE NSL CAP CROWN.
OPTION 1 - PLACEMENT OF A 6% CROWN GRADE USING SILTY CLAY BORROW MATERIAL.
OPTION 2 - PLACEMENT OF A 6% CROWN GRADE USING MUNICIPAL WASTE WITH A THIN LAYER OF SOIL

REFERENCES:
MEANS - MEANS SITE WORK COST DATA, 1988.
MEANS (1) - MEANS HEAVY CONSTRUCTION, 1988.
MEANS (2) - MEANS SITE WORK COST DATA, 1986

TABLE 8

NSL/ECC CIVIL ENGINEERING PREDESIGN REPLACEMENT COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST	ASSUMPTIONS	REFERENCE
REPLACEMENT COSTS						
1. TREATMENT PLANT					REPLACEMENT AT YEAR 15. FLOW DROPS TO 66 GPM AFTER 5 YEARS.	
INFLUENT PUMPING						
EQUALIZATION/STORAGE	1	LS	100,000	100,000	100,000 GALLON EQUALIZATION/STORAGE TANK	MEANS 13.1-77-090
PUMPS	2	EA	6,600	13,200	SUBMERSIBLE PUMP	FLYGT
PRECIPITATION SYSTEM						
IN-LINE MIXER	1	EA	1,550	1,550	4" IN-LINE MIXER	LIGHTNIN
PRECIPITATION SYSTEM PACKAGE	1	LS	87,000	87,000	AVERAGE PRICE OF TWO SYSTEMS	PARKSON/GENERAL FILTER
FILTER PRESS	1	LS	47,000	47,000	J-PRESS, 15 CU FT	DRYDON EQUIPMENT
SOLIDS STORAGE TANK	1	LS	1,200	1,200	FRP TANK	
NEUTRALIZATION TANK	1	LS	2,200	2,200	STEEL TANK	
STARTUP	4	DAY	500	2,000		
PACT SYSTEM						
PACT PACKAGE	1	LS	585,000	585,000	MODEL 55-A	ZIMPRO
FILTER PRESS	1	LS	47,000	47,000	J-PRESS, 15 CU FT	DRYDON EQUIPMENT
STARTUP	4	DAY	500	2,000		
GRANULAR MEDIA FILTER	1	LS	55,000	55,000	AVERAGE PRICE OF TWO SYSTEMS	PARKSON/AQUA-AEROBICS
OTHER						
AIR COMPRESSOR	1	LS	16,000	16,000		
INSTRUMENTATION AND CONTROLS	1	LS	41,000	41,000		
RETROFIT EXPENSES	1	LS	20,000	20,000		
SUBTOTAL (TO NEAREST $1000)				$1,020,000		

NOTE: THE TREATMENT COSTS INCLUDED IN THIS ESTIMATE REFLECT THOSE USED IN THE CAA DATED 12/5/86 AND HAVE A CONFIDENCE OF +50 -30.

NSL/ECC CIVIL ENGINEERING PREDESIGN OPERATIONS AND MAINTENANCE COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST FIRST YEAR	TOTAL COST AFTER FIRST YEAR	ASSUMPTIONS	REFERENCE
DIRECT OPERATIONS AND MAINTENANCE COSTS							
1. MONITORING ($/SAMPLING ROUND)						QUARTERLY FOR 1ST YEAR, SEMI-ANNUALLY THEREAFTER FOR GROUNDWATER, OTHERS SEMI-ANNUALLY	
MONITORING WELLS	41	EA	1400	229,600	30,800	14 WELLS AFTER FIRST YEAR, $1100/WELL	CLP AND ROCKY MTN.
LABOR FOR MONITORING WELLS	6	DAY	1000	24,000	12,000	1 E1, 2 TECH'S 6 DAYS	J. KEISER/GLO
SURFACE WATER	8	EA	1400	22,400	22,400		
SEDIMENT	8	EA	1600	25,600	25,600		
LABOR FOR SURFACE SAMPLES	1	DAY	600	1,200	1,200	1 E1, 1 TECH, 1 DAY , SEMI-ANNUALLY	J. KEISER/GLO
AIR QUALITY MONITORING	1	LS	700	1,400	1,400	HNu, OVA - 1 E3, 1 TECH, 1 DAY , SEMI-ANNUALLY	G. MARQUARTE/GLO
FIELD BLANKS							J. KEISER/GLO
GROUNDWATER	2	EA	1400	11,200	4,400	$1100/WELL AFTER 1 YEAR	
SURFACE WATER	1	EA	1400	2,800	2,800		
SEDIMENT	1	EA	1600	3,200	3,200		
DUPLICATES							J. KEISER/GLO
GROUNDWATER	2	EA	1400	11,200	4,400	$1100/WELL AFTER 1 YEAR	
SURFACE WATER	1	EA	1400	2,800	2,800		
SEDIMENT	1	EA	1600	3,200	3,200		
SHIPPING CHARGES	1	LS	2000	8,000	4,000	3 SAMPLES/COOLER - $100/COOLER	R. STREHLOW/GLO
2. TREATMENT PLANT OPERATION ($/YEAR)							
TREATMENT SYSTEM FLOW RATE @ 101 GPM - - FIRST 5 YEARS							
INFLUENT PUMPING							
ELECTRICITY	19600	kWh	0.05	980			
PRECIPITATION SYSTEM							
ELECTRICITY	6540	kWh	0.05	327			
SLUDGE HAULING	861	TON	45	38,745			
SLUDGE DISPOSAL	861	TON	80	68,880			
CHEMICAL USAGE							
FERROUS SULFATE	80	LB	2.11	169		AS FERROUS SULFATE HEPTAHYDRIDE	CHISMAN CREEK FS
ALKALI (LIME)	369800	LB	0.05	18,490			EPA/540/2-84-0039
POLYMER USAGE	879	LB	3.35	2,945		2 PPM PERCOL 776	CHISMAN CREEK FS
ACID USAGE	-MINIMAL-	LB					
PACT SYSTEM							
ELECTRICITY	770000	kWh	0.05	38,500			
SOLIDS HAULING	193	TON	45	8,685			
SOLIDS DISPOSAL	193	TON	80	15,440			
CARBON USAGE	136000	LB	0.4	54,400		0.5 lb PAC/lb COD	ZIMPRO
OTHER EQUIPMENT							
AIR COMPRESSOR - ELECTRICITY	164000	kWh	0.05	8,200			
MAINTENANCE	8352	HR	30	250,560		4 FULL-TIME OPERATORS	
SUPERVISION	2088	HR	45	93,960		FULL-TIME SUPERVISOR	
MONITORING	24	EA	1400	33,600		INFLUENT AND EFFLUENT SAMPLE ONCE PER MONTH	J. KEISER/GLO
SAMPLE SHIPPING CHARGES	24	EA	100	2,400		2 SHIPMENTS PER MONTH	R. STREHLOW/GLO
TREATMENT SYSTEM FLOW RATE @ 66 GPM - - AFTER 5 YEARS							
INFLUENT PUMPING							
ELECTRICITY	19600	kWh	0.05	980			
PRECIPITATION SYSTEM							
ELECTRICITY	6540	kWh	0.05	327			
SLUDGE HAULING	333	TON	45	14,985			
SLUDGE DISPOSAL	333	TON	80	26,640			

NSL/ECC CIVIL ENGINEERING PREDESIGN OPERATIONS AND MAINTENANCE COSTS

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	TOTAL COST	ASSUMPTIONS	REFERENCE
DIRECT OPERATIONS AND MAINTENANCE COSTS						
CHEMICAL USAGE						
FERROUS SULFATE	33	LB	2.11	70	AS FERROUS SULFATE HEPTAHYDRIDE	CHISMAN CREEK FS
ALKALI (LIME)	148300	LB	0.05	7,415		EPA=540/2-84-0039
POLYMER USAGE	573	LB	3.35	1,920	2 PPM PERCOL 776	CHISMAN CREEK FS
ACID USAGE	-MINIMAL-	LB				
PACT SYSTEM						
ELECTRICITY	770000	kWh	0.05	38,500		
SOLIDS HAULING	40	TON	45	1,800		
SOLIDS DISPOSAL	40	TON	80	3,200		
CARBON USAGE	23000	LB	0.4	9,200	0.5 lb PAC/lb COD	ZIMPRO
OTHER EQUIPMENT						
AIR COMPRESSOR - ELECTRICITY	164000	kWh	0.05	8,200		
MAINTENANCE	8352	HR	30	250,560	4 FULL-TIME OPERATORS	
SUPERVISION	2088	HR	45	93,960	FULL-TIME SUPERVISOR	
MONITORING	24	EA	1400	33,600	INFLUENT AND EFFLUENT SAMPLE ONCE PER MONTH	J. KEISER/GLO
SAMPLE SHIPPING CHARGES	24	EA	100	2,400	2 SHIPMENTS PER MONTH	R. STREHLOW/GLO
3. PUMP ELECTRICITY ($/YEAR)						
GROUNDWATER INTERCEPTION SYSTEM	1	LS	2000	2,000		
LEACHATE COLLECTION SYSTEM	1	LS	1000	1,000		
4. INSPECTION ($/YEAR)						
SITE INSPECTION	1	LS	1800	3,600	1 E1, 1 TECH, 3 DAYS, TWICE PER YEAR	
5. OTHER MAINTENANCE ($/YEAR)						
GROUNDWATER/LEACHATE COLLECTION						
FRENCH DRAIN PUMP REPLACEMENT	1	EA	1000	1,000	REPLACE EVERY 5 YEARS	M. HINCHEY/GLO
LEACHATE COLLECTION PUMP REPLACEMENT	1	EA	500	500	REPLACE EVERY 5 YEARS	M. HINCHEY/GLO
REFURBISH WELL SCREENS						
MONITORING WELLS	1	LS	6000	6,000	CLEAN EVERY 10 YRS. - 2 WEEKS. LABOR, 2 PEOPLE	M. HINCHEY/GLO
CAP REPAIRS						
EROSION CONTROL	74	AC	225	16,650		EPA COST COMPENDIUM
FREEZE/THAW REPAIRS	74	AC	225	16,650		EPA COST COMPENDIUM
SETTLEMENT REPAIRS	9400	CY	10	94,000	FILL 2" SETTLEMENT OVER 50% OF LANDFILL YEARLY	
FENCE MAINTENANCE	1	LS	3600	3,600		
MOWING	74	AC	670	49,580		EPA COST COMPENDIUM
CLEAN TILE SYSTEM					CLEAN PIPELINE EVERY 5 YEARS	
LEACHATE COLLECTION SYSTEM	5720	LF	0.5	2,860		
GROUNDWATER INTERCEPTION SYSTEM	3100	LF	0.5	1,550		

NOTES:

1. DISPOSAL OF PRECIPITATION SLUDGE ASSUMED TO BE IN RCRA LANDFILL. NO FIXATION OF THE SLUDGE ASSUMED TO BE REQUIRED.

2. PACT CARBON SOLIDS ASSUMED TO BE DISPOSED OF IN RCRA LANDFILL. IF REGULATIONS REQUIRE INCINERATION
   ADDITIONAL COSTS ARE ASSUMED TO BE: ● $0.50 PER LB PACT CARBON SOLIDS
   COST (YEARS 1 THROUGH 5) $193,000 /YEAR
   COST (YEARS 6 THROUGH 30) $40,000 /YEAR

3. THE TREATMENT COSTS INCLUDED IN THIS ESTIMATE REFLECT THOSE USED IN THE CAA DATED 12/5/86 AND HAVE A CONFIDENCE OF +50 -30.

NSL/ECC CIVIL ENGINEERING PREDESIGN PRESENT WORTH

PRESENT WORTH (BASED ON ANNUAL CAPITAL COST) ANALYSIS

YEAR	ANNUAL CAPITAL COST $	ANNUAL O&M COST $	PRESENT WORTH 3%	PRESENT WORTH 5%	PRESENT WORTH 10%
0	$22,146,000 *		$22,146,000	$22,146,000	$22,146,000
1		$1,161,000	$1,127,180	$1,105,713	$1,055,453
2		$932,000	$878,503	$845,352	$770,251
3		$932,000	$852,910	$805,099	$700,221
4		$932,000	$828,073	$766,766	$636,565
5		$937,705	$808,874	$734,720	$582,240
6		$790,000	$661,617	$589,514	$445,931
7		$790,000	$642,349	$561,445	$405,396
8		$790,000	$623,634	$534,704	$368,543
9		$790,000	$605,472	$509,242	$335,039
10		$801,705	$596,549	$492,183	$309,089
11		$790,000	$570,720	$461,905	$276,887
12		$790,000	$554,098	$439,904	$251,718
13		$790,000	$537,958	$418,961	$228,831
14		$790,000	$522,293	$399,005	$208,031
15	$1,020,000	$795,705	$1,165,447	$873,390	$434,662
16		$790,000	$492,312	$361,915	$171,928
17		$790,000	$477,966	$344,677	$156,294
18		$790,000	$464,046	$328,269	$142,089
19		$790,000	$450,537	$312,635	$129,173
20		$801,705	$443,896	$302,163	$119,165
21		$790,000	$424,672	$283,571	$106,753
22		$790,000	$412,301	$270,069	$97,052
23		$790,000	$400,293	$257,208	$88,227
24		$790,000	$388,633	$244,963	$80,209
25		$795,705	$380,045	$234,980	$73,444
26		$790,000	$366,323	$222,188	$66,289
27		$790,000	$355,658	$211,609	$60,261
28		$790,000	$345,301	$201,529	$54,779
29		$790,000	$335,244	$191,931	$49,802
30		$801,705	$330,302	$185,499	$45,946
TOTAL O & M PRESENT WORTH			$16,388,000	$13,000,000	$8,206,000
TOTAL REPLACEMENT PRESENT WORTH			$655,000	$491,000	$244,000
TOTAL PRESENT WORTH			$39,189,000	$35,637,000	$30,596,000

NOTES:

1. DISPOSAL OF PRECIPITATION SLUDGE TO BE IN A RCRA LANDFILL. NO FIXATION ASSUMED TO BE REQUIRED.

2. IF INCINERATION OF PACT SOLIDS AT $0.50 / LB IS REQUIRED, THE ADDITIONAL PRESENT WORTH (WHICH IS NOT INCLUDED) IS : $1,485,000 (3%) $1,277,000 (5%) $957,000 (10%)

3. THE PRESENT WORTH OF THE PACT SOLIDS DISPOSAL IN A RCRA LANDFILL, TO BE SUBTRACTED FROM THE TOTAL PRESENT WORTH IS : $119,000 (3%) $102,000 (5%) $77,000 (10%)

4. THE TREATMENT COSTS INCLUDED IN THIS ESTIMATE REFLECT THOSE USED IN THE CAA DATED 12/5/86 AND HAVE A CONFIDENCE OF +50 -30.

* OPTION 1 - PLACEMENT OF 6% CROWN USING SILTY CLAY BORROW MATERIAL.

ANNUAL O & M COSTS:

ANNUAL COSTS	FIRST YEAR	AFTER FIRST YEAR
MONITORING ($/SAMPLING ROUND)		
MONITORING WELLS	229,600	30,800
LABOR - MONITORING WELLS	24,000	12,000
SURFACE WATER	22,400	22,400
SEDIMENT	25,600	25,600
LABOR - SURFACE SAMPLES	1,200	1,200
AIR QUALITY MONITORING	1,400	1,400
FIELD BLANKS		
GROUNDWATER	11,200	4,400
SURFACE WATER	2,800	2,800
SEDIMENT	3,200	3,200
DUPLICATES		
GROUNDWATER	11,200	4,400
SURFACE WATER	2,800	2,800
SEDIMENT	3,200	3,200
SHIPPING CHARGES	8,000	4,000
$/YR	$347,000	$118,000
ANNUAL COSTS (SAME EVERY YEAR, $/YR)		
INSPECTION	3,600	
GEN. MAINTENANCE		
CAP REPAIRS	122,600	
FENCE MAINTENANCE	3,600	
MOWING	45,560	
PUMP ELECTRICITY		
GROUNDWATER INTERCEPTION	2,000	
LEACHATE COLLECTION	1,000	
TOTAL ANNUAL COSTS ($/YEAR)	$178,000	
NON-ANNUAL MAINTENANCE ($/ACTIVITY)		
REFURBISH SCREENS (EVERY 10 YEARS)		
MONITORING WELLS	$6,000	
GROUNDWATER/LEACHATE COLLECTION		
PUMP REPLACEMENT (EVERY 5 YEARS)		
FRENCH DRAIN	$1,000	
LEACHATE COLLECTION	$500	
CLEAN TILE SYSTEM (EVERY 5 YEARS)		
LEACHATE COLLECTION SYSTEM	$2,955	
GROUNDWATER INTERCEPTION SYSTEM	$1,250	

TREATMENT SYSTEM FLOW RATE @ 101 GPM - FIRST 5 YEARS	
INFLUENT PUMPING	
ELECTRICITY	980
PRECIPITATION SYSTEM	
ELECTRICITY	327
SLUDGE HAULING	38,745
SLUDGE DISPOSAL	68,880
CHEMICAL USAGE	
FERROUS SULFATE	169
ALKALI	18,490
POLYMER	2,945
PACT SYSTEM	
ELECTRICITY	38,500
SOLIDS HAULING	8,685
SOLIDS DISPOSAL	15,440
CARBON USAGE	54,400
AIR COMPRESSOR	
ELECTRICITY	8,200
MAINTENANCE	250,560
SUPERVISION	93,960
EFFLUENT MONITORING	33,600
SAMPLE SHIPPING CHARGES	2,400
OPERATING COST	$636,000

TREATMENT SYSTEM FLOW RATE @ 66 GPM - AFTER 5 YEARS	
INFLUENT PUMPING	
ELECTRICITY	980
PRECIPITATION SYSTEM	
ELECTRICITY	327
SLUDGE HAULING	14,985
SLUDGE DISPOSAL	26,640
CHEMICAL USAGE	
FERROUS SULFATE	70
ALKALI	7,415
POLYMER	1,920
PACT SYSTEM	
ELECTRICITY	38,500
SOLIDS HAULING	1,800
SOLIDS DISPOSAL	3,200
CARBON USAGE	9,200
AIR COMPRESSOR	
ELECTRICITY	8,200
MAINTENANCE	250,560
SUPERVISION	93,960
EFFLUENT MONITORING	33,600
SAMPLE SHIPPING CHARGES	2,400
OPERATING COST	$494,000

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GLT821/73

Appendix A
CONCEPTUAL DESIGN DRAWINGS
FOR THE
NSL/ECC SITE

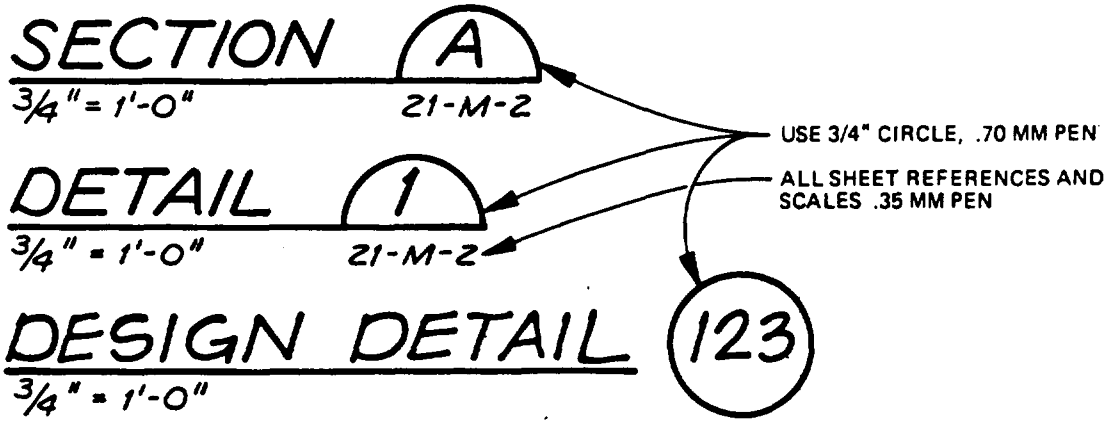
TOPOGRAPHIC LEGEND

	PROPERTY LINE AND/OR RIGHT-OF-WAY LINE
—x—x—x—x—x—	FENCE LINE
	EXISTING STRUCTURE TO BE REMOVED *
	EXISTING STRUCTURE *
	EXISTING A.C. PAVEMENT *
	NEW A.C. PAVEMENT *
	GRAVEL SURFACE *
	CONCRETE WALK *
	DITCH SHOWING DIRECTION OF FLOW
× 1000	EXISTING GRADE
⊗ 1000	FINISH GRADE
1000	EXISTING CONTOUR
1000	NEW CONTOUR
	EXISTING CATCH BASIN
	NEW CATCH BASIN
3:1	EXISTING EMBANKMENT, SLOPE AS INDICATED
4:1	NEW EMBANKMENT, SLOPE AS INDICATED
	LIMITS OF TOPSOIL AND SEEDING (UNLESS OTHERWISE NOTED)
	TREE
	SIGN
TP-2	TEST PIT LOCATION AND NUMBER
B-1	BORING LOCATION AND NUMBER
△ P-3	PIEZOMETER LOCATION AND NUMBER
	EXISTING UTILITY POLE
	NEW UTILITY POLE
○	EXISTING MANHOLE
●	NEW MANHOLE

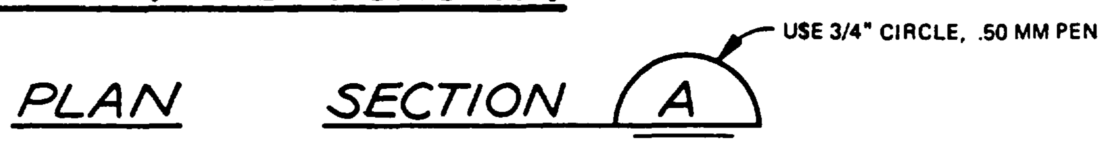
* SYMBOL ONLY WHERE REQUIRED FOR CLARITY

NOTE:
IN GENERAL, EXISTING STRUCTURES AND FACILITIES ARE NOTED AS "EXISTING" AND ARE SHOWN IN LIGHT LINE WEIGHTS, OR AS SCREENED BACKGROUND. NEW STRUCTURES ARE SHOWN IN HEAVY LINE WEIGHTS.

TITLES (WHERE SHOWN)

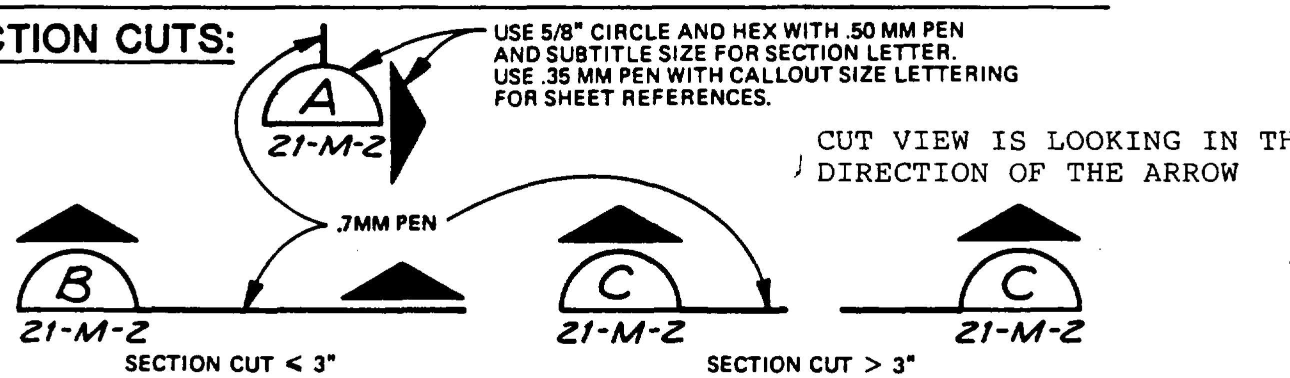


SUBTITLES (WHERE SHOWN)



CALLOUTS (WHERE TAKEN)

SECTION CUTS:



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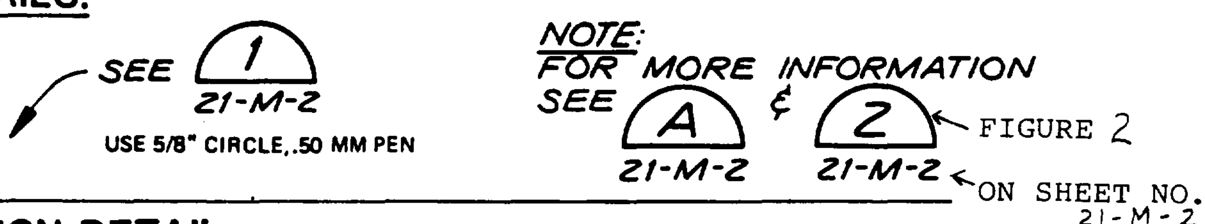


DESIGN DETAIL:

NOTES:

1. FOR LETTERING SIZES SEE FIGURE 1-D.
2. FOR PREPRINTED "DETAIL AND SECTION DESIGNATION," SEE FIGURE 1-I.

DETAIL AND SECTION DESIGNATION

PROPERTY SURVEYS AND PLATS

(WHERE APPROPRIATE)

LEGEND

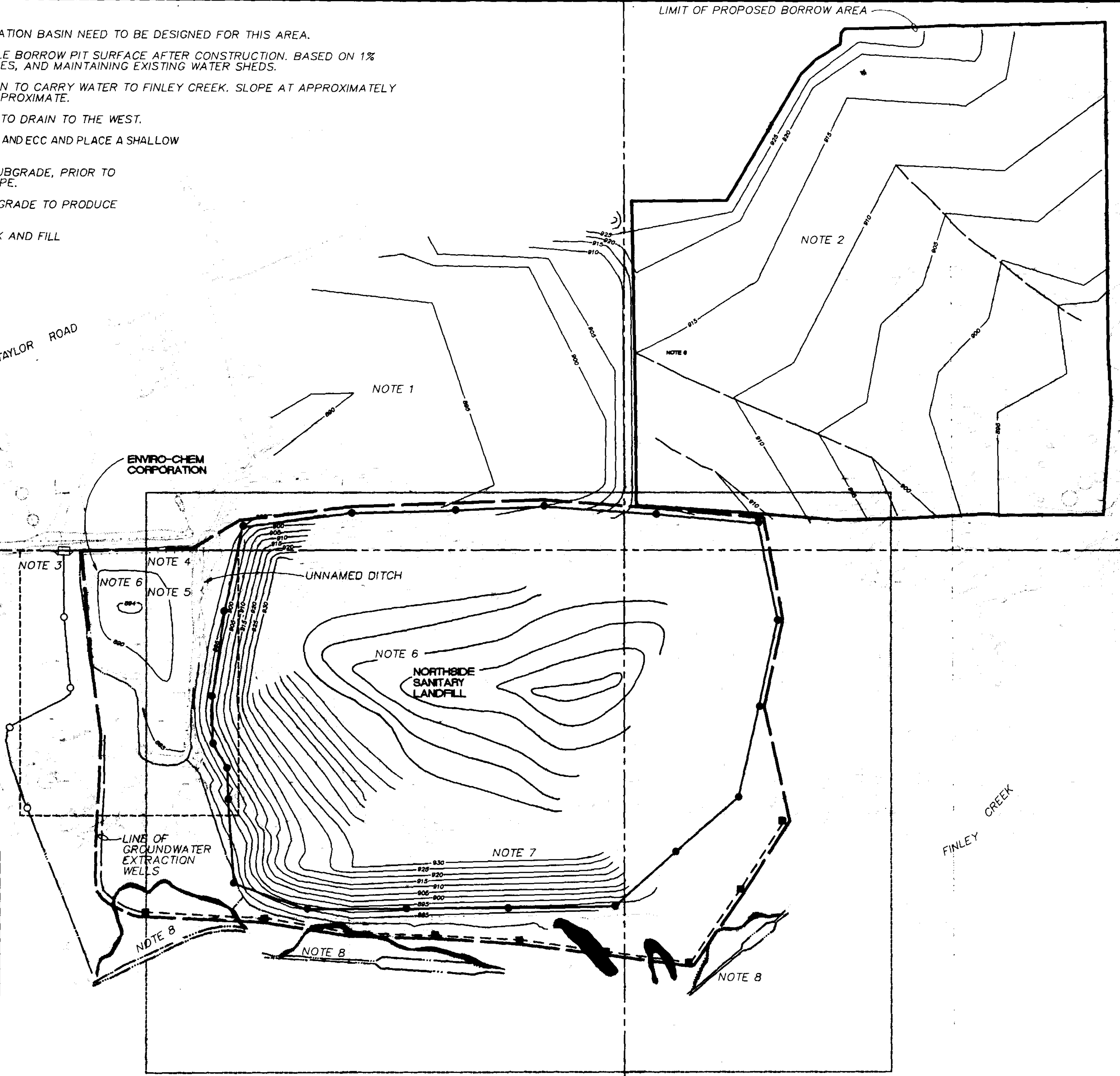
	PL	PROPERTY LINE
	R/W	RIGHT-OF-WAY LINE
		EASEMENT LINE
		STREET CENTERLINE
(.5, .7, 1.0, OR 1.4 PEN)		SURVEY OR SUBDIVISION BOUNDARY
	x x x	FENCE
(3/16")		BRASS CAP
(1/8")	○	FOUND 5/8" IRON ROD
(1/16")	○	FOUND 1/2" IRON ROD
(1/8")	●	SET 5/8" IRON ROD
(1/16")	●	SET 1/2" IRON ROD
(1/8" & 3/64")	◎	FOUND IRON PIPE
(1/8")		SET P.K. NAIL
(1/8" & 3/64")	◎	SET LEAD PLUG WITH TACK
	(S10°09'15"E 37.09')	DATA OF RECORD
	2	LOT NUMBER
	$\boxed{3}$	BLOCK NUMBER
(1/8")	TH-2 ⊕ TP-3	TEST HOLE (TH)/ TEST PIT (TP)
(1/16")		UTILITY POLE

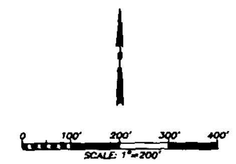
NOTE:
SYMBOL SIZES—*(1/8")* ARE NOT TO BE INCLUDED IN ACTUAL LEGENDS.

9-22-88 C-1.DWG

NOTES:

1. DRAINAGE DITCH SIZING AND EQUALIZATION BASIN NEED TO BE DESIGNED FOR THIS AREA.
2. FINAL CONTOURS REPRESENT POSSIBLE BORROW PIT SURFACE AFTER CONSTRUCTION. BASED ON 1% TO 2% BOTTOM SLOPE, 17% SIDE SLOPES, AND MAINTAINING EXISTING WATER SHEDS.
3. INSTALL A 48" DIAMETER STORM DRAIN TO CARRY WATER TO FINLEY CREEK. SLOPE AT APPROXIMATELY ½ PERCENT. ALIGNMENT SHOWN IS APPROXIMATE.
4. REGRADE THE DITCH NORTH OFF ECC TO DRAIN TO THE WEST.
5. FILL THE UNNAMED DITCH BETWEEN NSL AND ECC AND PLACE A SHALLOW STORM RUNOFF TRENCH.
6. CONTOURS SHOW PROPOSED FINAL SUBGRADE, PRIOR TO CONSTRUCTION OF COVER, OF 6% SLOPE.
7. SAME AS NOTE 4 EXCEPT SLOPE SUBGRADE TO PRODUCE 25% GRADE.
8. CUT NEW CHANNEL FOR FINLEY CREEK AND FILL ABANDONED CHANNELS.

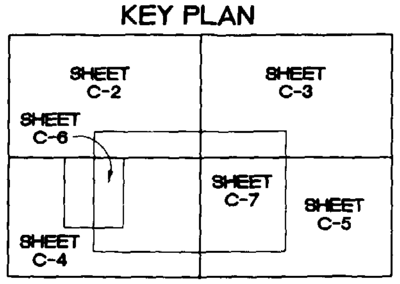




LEGEND

- NEW CONTOURS
- NEW SURFACE WATER DITCHES
- APPROXIMATE LIMITS OF FINAL COVER
- APPROXIMATE ALIGNMENT OF LEACHATE COLLECTION SYSTEM WITH CLEANOUTS. EXACT ALIGNMENT IS TO BE DETERMINED AFTER EXTENT OF REFUSE IS FURTHER DEFINED.
- APPROXIMATE ALIGNMENT OF GROUNDWATER INTERCEPTOR TRENCH WITH CLEANOUTS.
- APPROXIMATE ALIGNMENT OF GROUNDWATER EXTRACTION WELLS. EXACT NUMBER AND POSITION OF WELLS, AND NEED FOR A SLURRY WALL IS TO BE DETERMINED AFTER PUMP TEST.
- APPROXIMATE PORTIONS OF FINLEY CREEK TO BE ABANDONED AND FILLED IN.
- APPROXIMATE LOCATIONS OF REROUTED PORTIONS OF FINLEY CREEK.
- APPROXIMATE LOCATION OF STORM DRAIN FOR CLEAN WATER. EXACT SPECIFICATIONS FOR PIPE HAS YET TO BE DETERMINED.

KEY PLAN



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APVD	

NO	DATE	REVISION	BY	APVD

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VERIFY SCALES

BAR IS ONE INCH ON ORIGINAL DRAWING.

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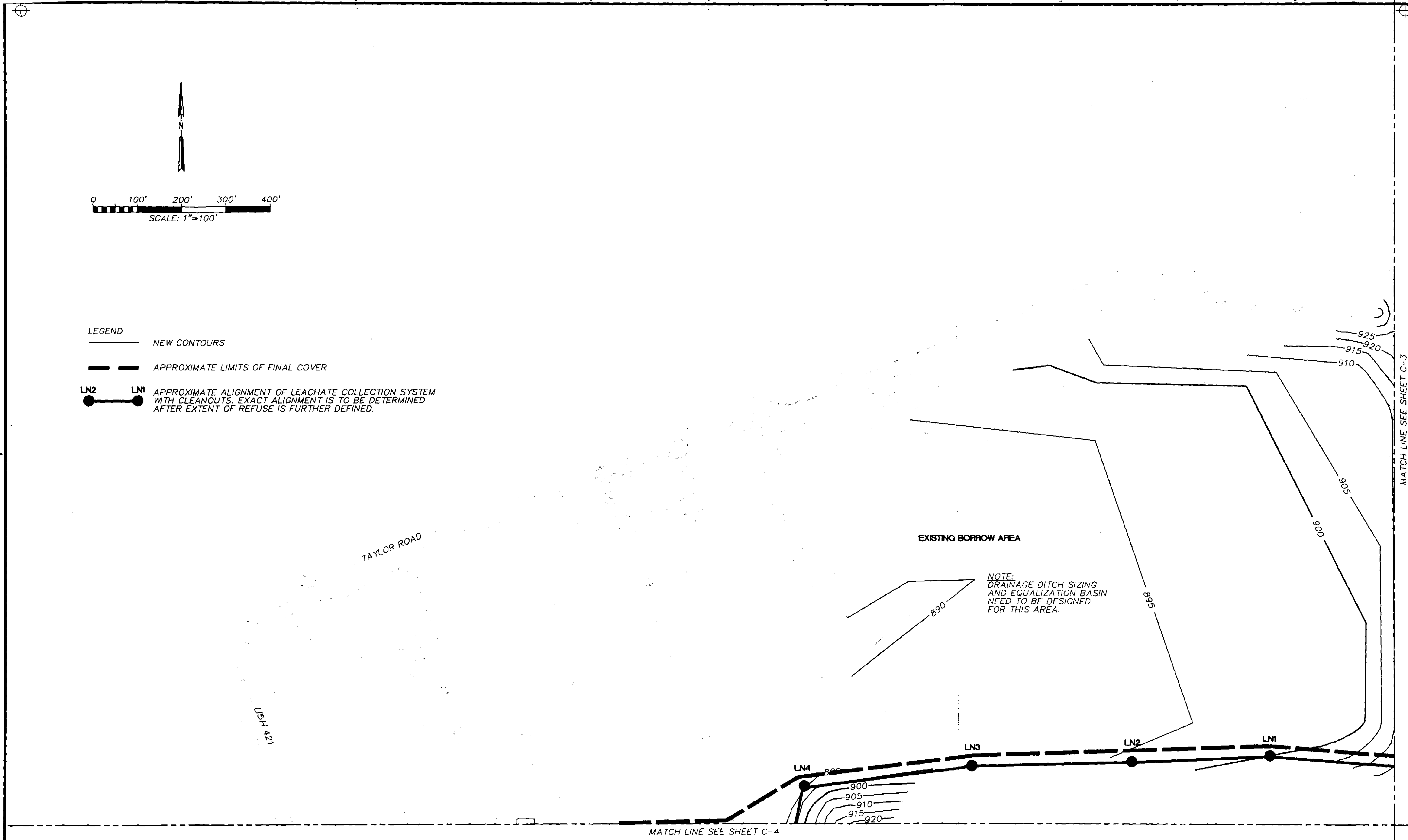
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY.

NORTHSIDE SANITARY LANDFILL AND ENVIRO-CHEM. CORP REMEDIAL DESIGN

CONCEPTUAL SITE PLAN WITH PIPING

SHEET	C-1
DWG NO	
DATE	SEPT 1988
PROJ NO.	

PRELIMINARY



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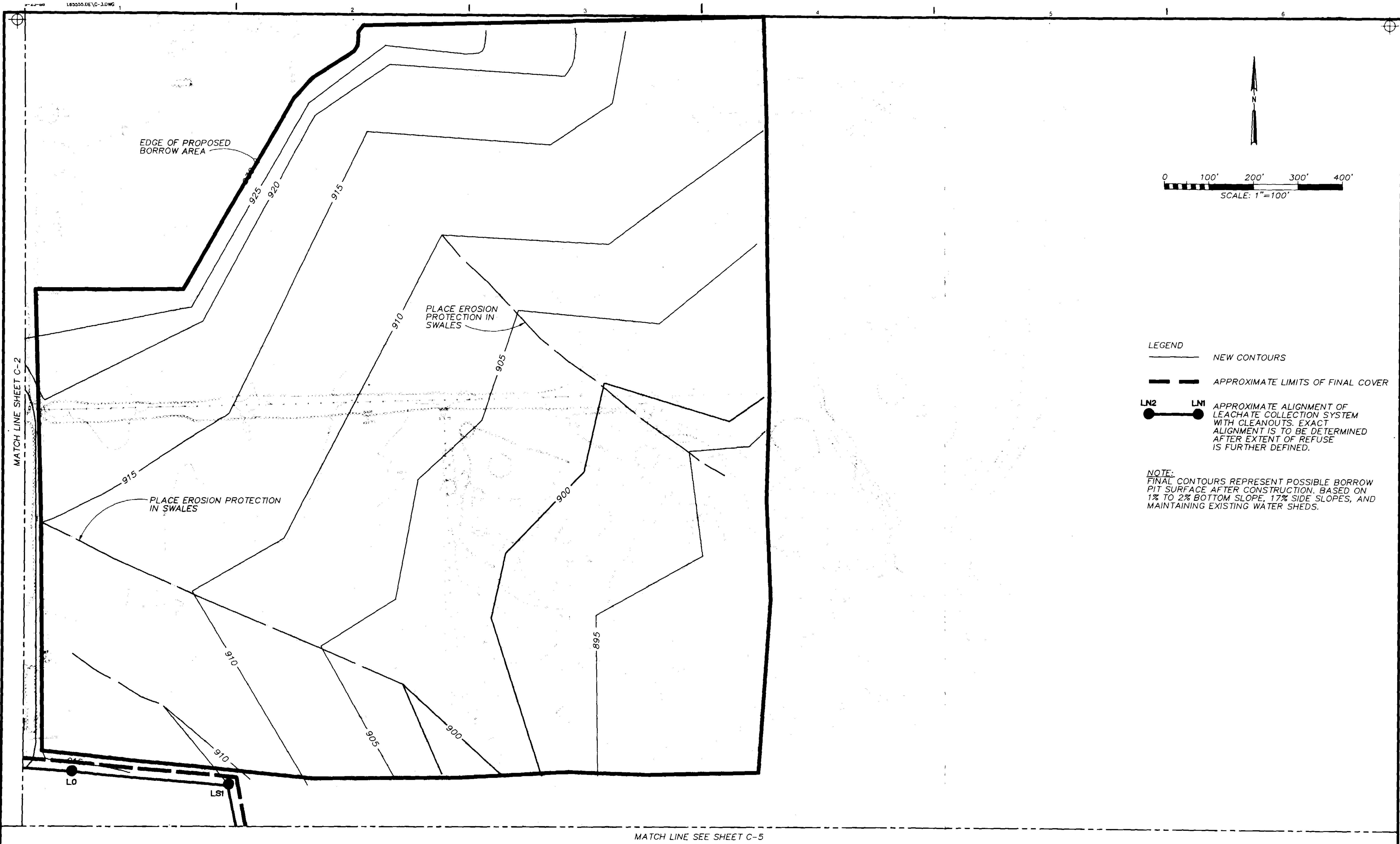
NORTHSIDE SANITARY LANDFILL AND ENVIRO-CHEM. CORP REMEDIAL DESIGN

NW QUADRANT SITE PLAN WITH PIPING

SHEET	C-2
DWG NO	
DATE	SEPT 1988
PROJ NO	

PRELIMINARY



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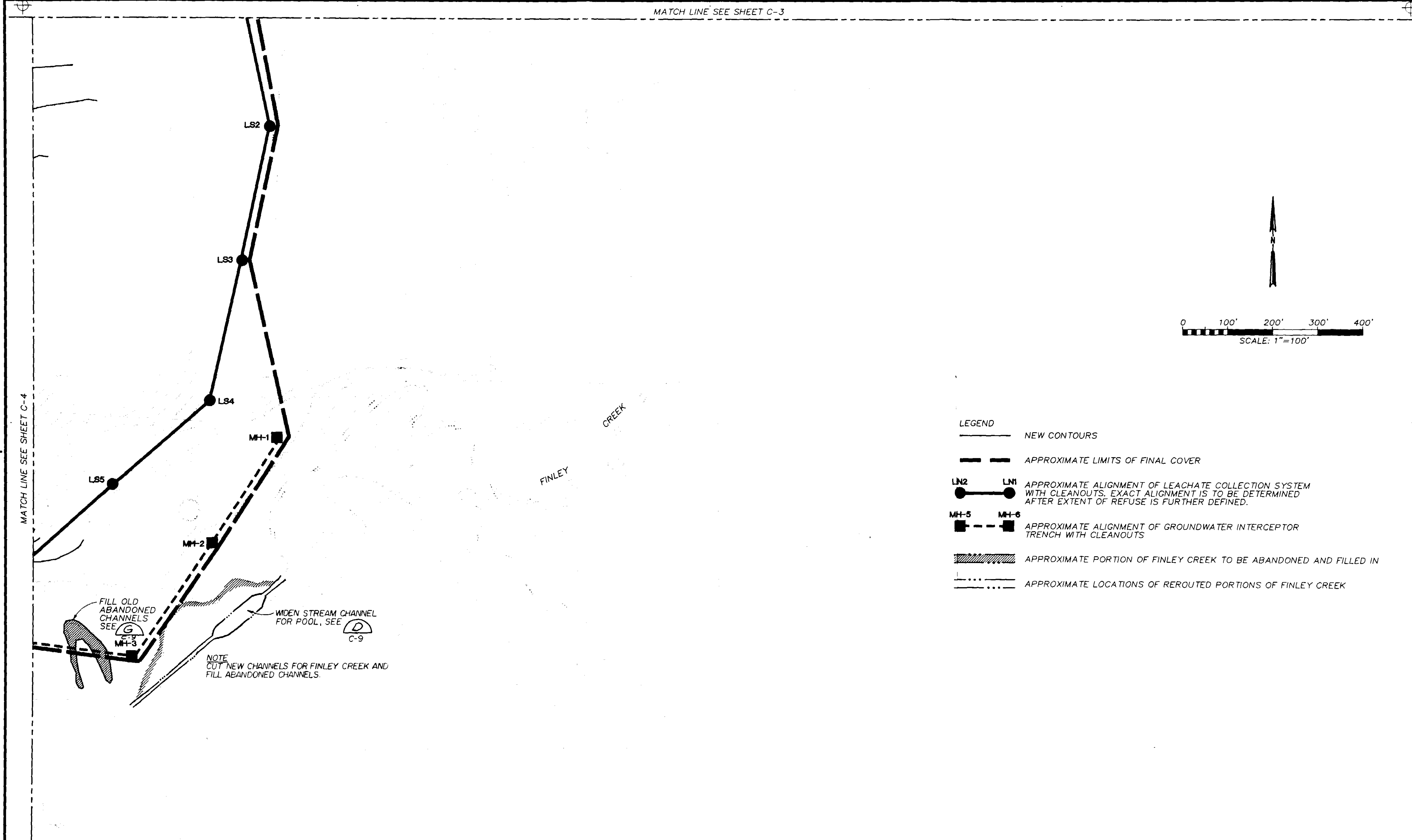
NORTHSIDE SANITARY LANDFILL AND ENVIRO-CHEM. CORP REMEDIAL DESIGN

NE QUADRANT SITE PLAN WITH PIPING

SHEET C-3
DWG NO.
DATE SEPT 1988
PROJ NO.

PRELIMINARY



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NORTHSIDE SANITARY LANDFILL AND ENVIRO-CHEM. CORP REMEDIAL DESIGN

SE QUADRANT SITE PLAN WITH PIPING

SHEET C-5

DWG NO.

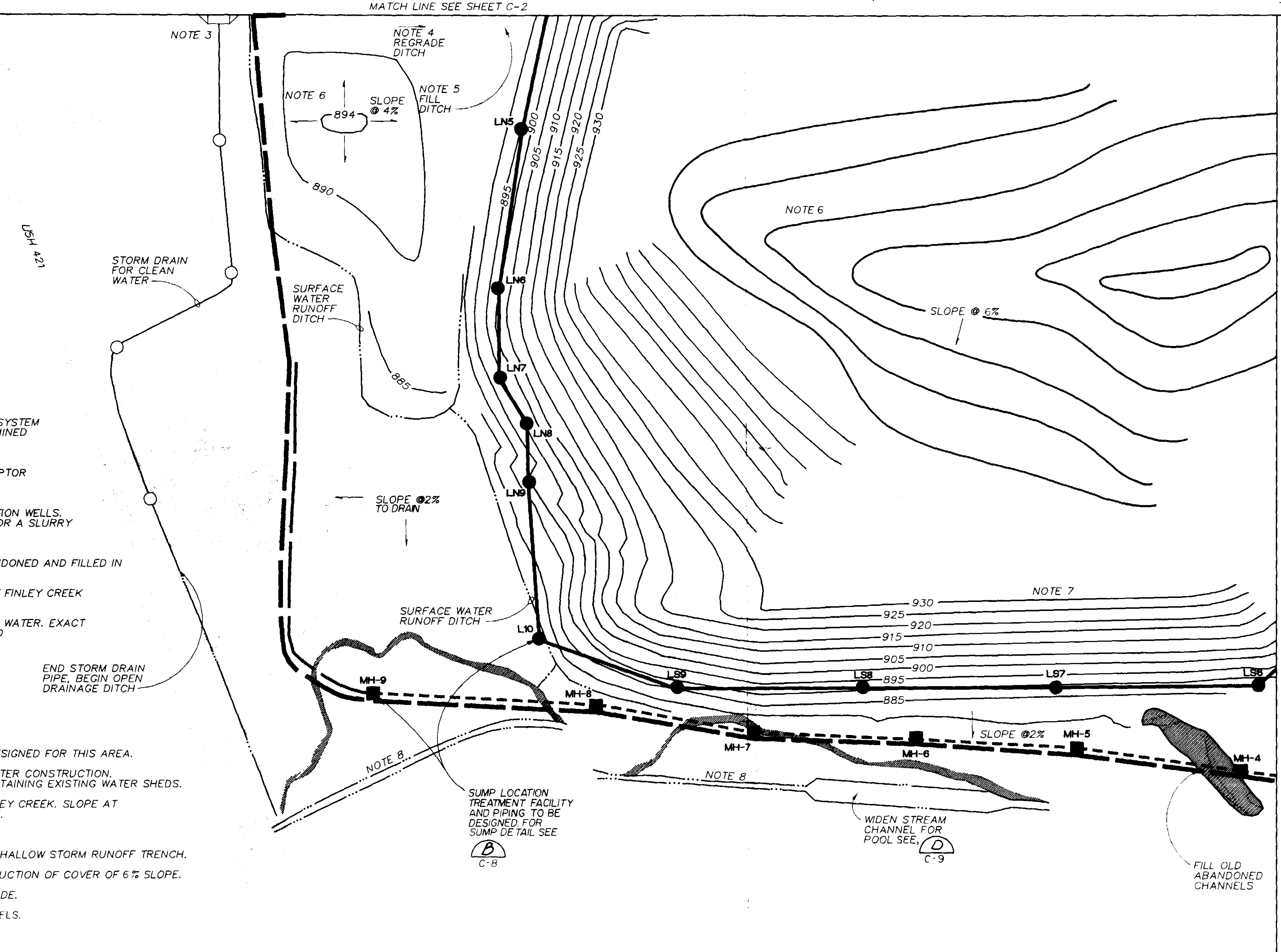
DATE SEPT 1988

PROJ NO.

PRELIMINARY

9-23-88 C-4.DWG

MATCH LINE SEE SHEET C-2



MATCH LINE SEE SHEET C-5

LEGEND

———	NEW CONTOURS
— —	APPROXIMATE LIMITS OF FINAL COVER
LN2 ●——● LN1	APPROXIMATE ALIGNMENT OF LEACHATE COLLECTION SYSTEM WITH CLEANOUTS. EXACT ALIGNMENT IS TO BE DETERMINED AFTER EXTENT OF REFUSE IS FURTHER DEFINED.
MH-5 ■- - -■ MH-6	APPROXIMATE ALIGNMENT OF GROUNDWATER INTERCEPTOR TRENCH WITH CLEANOUTS
— —	APPROXIMATE ALIGNMENT OF GROUNDWATER EXTRACTION WELLS. EXACT NUMBER AND POSITION OF WELLS AND NEED FOR A SLURRY WALL IS TO BE DETERMINED AFTER PUMP TEST.
(hatched)	APPROXIMATE PORTION OF FINLEY CREEK TO BE ABANDONED AND FILLED IN
—···—	APPROXIMATE LOCATIONS OF REROUTED PORTIONS OF FINLEY CREEK
○——○	APPROXIMATE LOCATION OF STORM DRAIN FOR CLEAN WATER. EXACT SPECIFICATIONS FOR PIPE HAS YET TO BE DETERMINED

NOTES:

*1. DRAINAGE DITCH SIZING AND EQUALIZATION BASIN NEED TO BE DESIGNED FOR THIS AREA.

*2. FINAL CONTOURS REPRESENT POSSIBLE BORROW PIT SURFACE AFTER CONSTRUCTION. BASED ON 1% TO 2% BOTTOM SLOPE, 17% SIDE SLOPES, AND MAINTAINING EXISTING WATER SHEDS.

3. INSTALL A 48" DIAMETER STORM DRAIN TO CARRY WATER TO FINLEY CREEK. SLOPE AT APPROXIMATELY ½ PERCENT. ALIGNMENT SHOWN IS APPROXIMATE.

4. REGRADE THE DITCH NORTH OF ECC TO DRAIN TO THE WEST.

5. FILL THE UNNAMED DITCH BETWEEN NSL AND ECC AND PLACE A SHALLOW STORM RUNOFF TRENCH.

6. CONTOURS SHOW PROPOSED FINAL SUBGRADE, PRIOR TO CONSTRUCTION OF COVER OF 6% SLOPE.

7. SAME AS NOTE 4 EXCEPT SLOPE SUBGRADE TO PROVIDE 25% GRADE.

8. CUT NEW CHANNEL FOR FINLEY CREEK AND FILL ABANDONED CHANNELS.

* NOTE NOT REFERRED TO ON THIS SHEET.

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DR M.LEPKOWSKI
CHK
APVD

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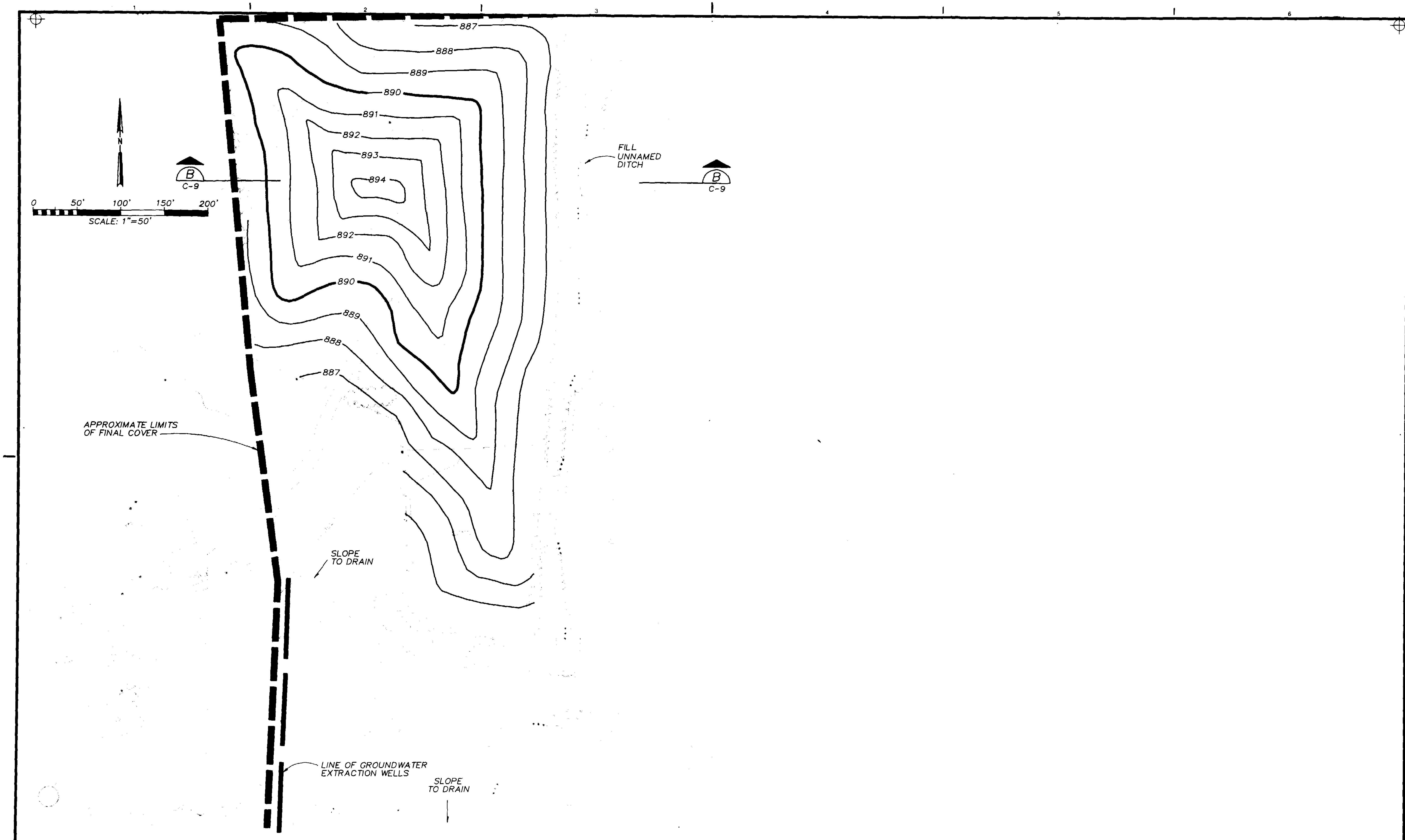
SW QUADRANT SITE PLAN WITH PIPING

SHEET C-4
DWG NO
DATE SEPT 1988
PROJ NO

PRELIMINARY



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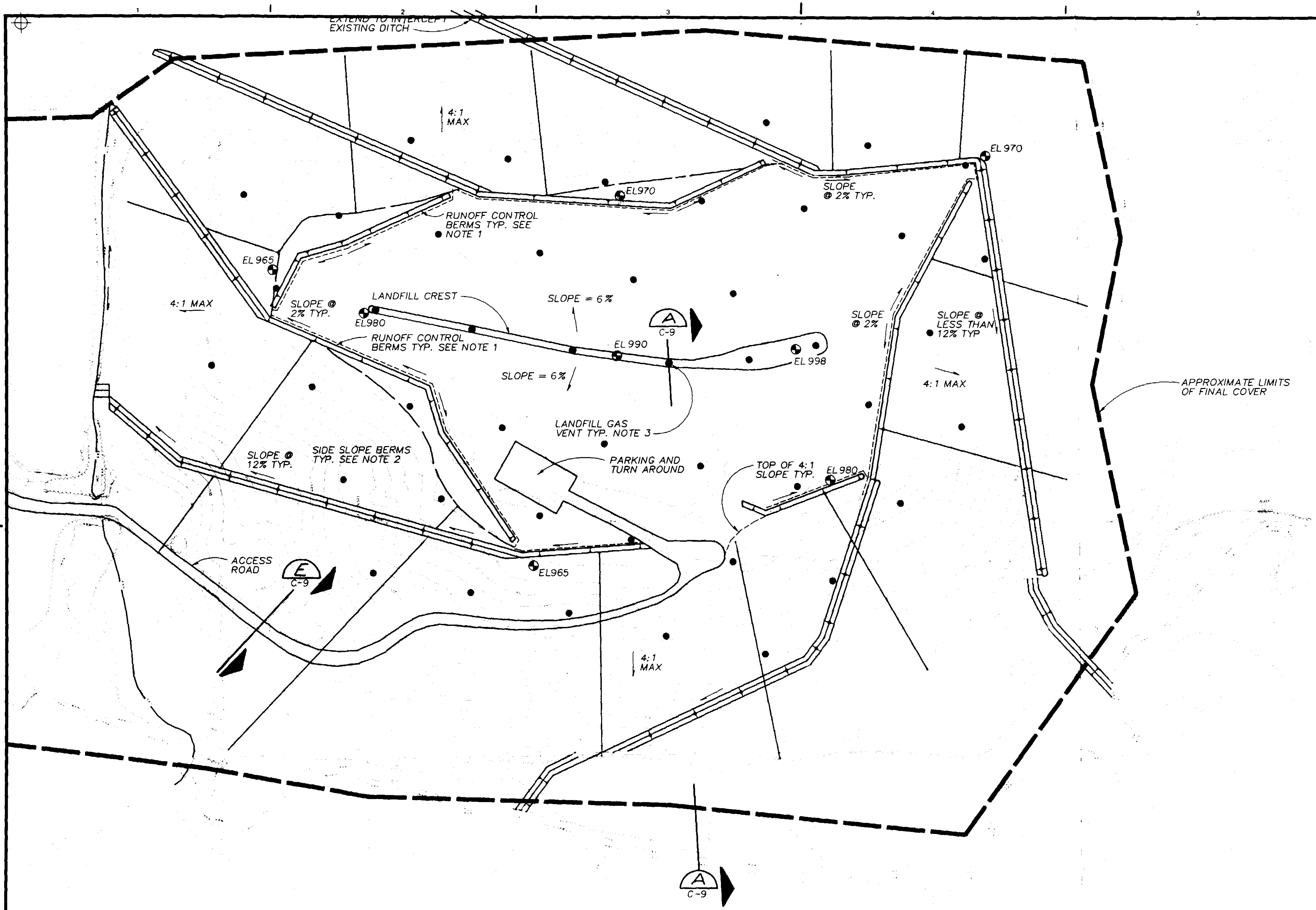
ECC SITE PLAN

SHEET	C-6
DWG NO.	
DATE	SEPT 1988
PROJ NO.	

PRELIMINARY



N

0 100 200 300 400
SCALE: 1"=100'

NOTES:

1. SLOPE RUNOFF CONTROL BERMS AT 1% TO 2% ON TOP PORTION OF LANDFILL. CONTRACTOR SHALL ALIGN DITCHES TO DRAIN THE AREAS SHOWN AND MAINTAIN SPECIFIED SLOPE. RUNOFF CONTROL BERMS SHALL BE GRASS LINED.
2. SLOPE SIDE SLOPE BERMS AT 10% TO 12% ON 4:1 SIDE SLOPES. CONSTRUCT DITCHES AS NECESSARY TO CONVEY WATER TO THE RECEIVING STREAM.
3. GAS FLARE/VENT LOCATIONS ARE APPROXIMATE. GAS COLLECTION SYSTEM HAS NOT BEEN DESIGNED.

● APPROXIMATE GAS FLARE/VENT LOCATIONS

APPROXIMATE FINISHED SURFACE ELEVATIONS.

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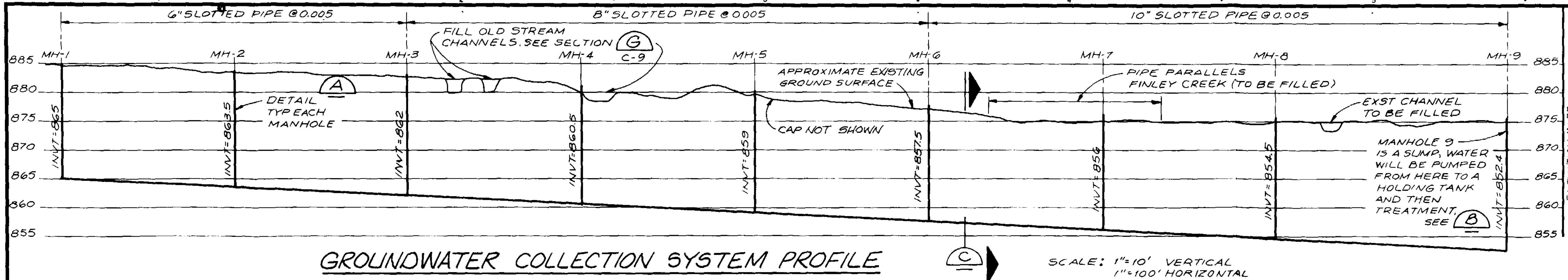
NSL FINISHED GRADING WITH GAS COLLECTION VENTS

SHEET C-7
DWG NO
DATE SEPT 1988
PROJ NO.

PRELIMINARY

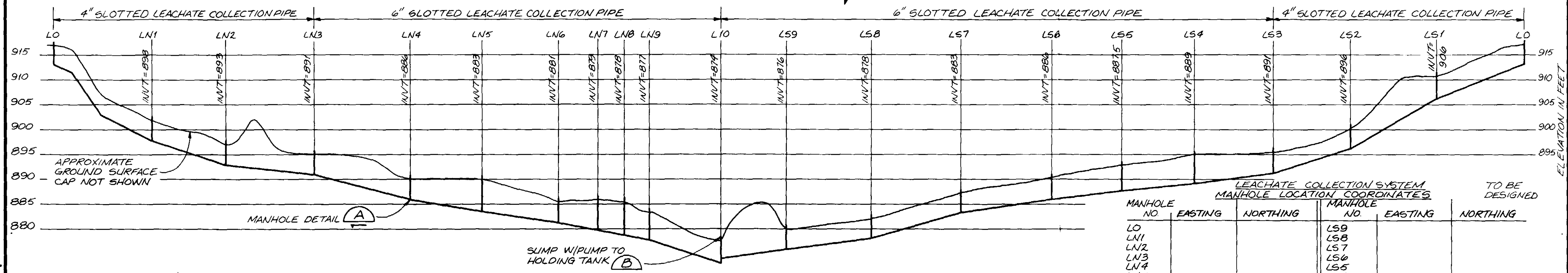


GROUNDWATER COLLECTION SYSTEM PROFILE

SCALE: 1"=10' VERTICAL
1"=100' HORIZONTAL

GROUNDWATER COLLECTION SYSTEM MANHOLE LOCATION COORDINATES

MANHOLE NO.	EASTING	NORTHING
MH-1	728,030	921,320
MH-2	727,880	921,130
MH-3	727,710	920,870
MH-4	727,420	920,920
MH-5	727,110	920,950
MH-6	726,870	920,970
MH-7	726,520	920,990
MH-8	726,220	921,030
MH-9	725,810	921,050



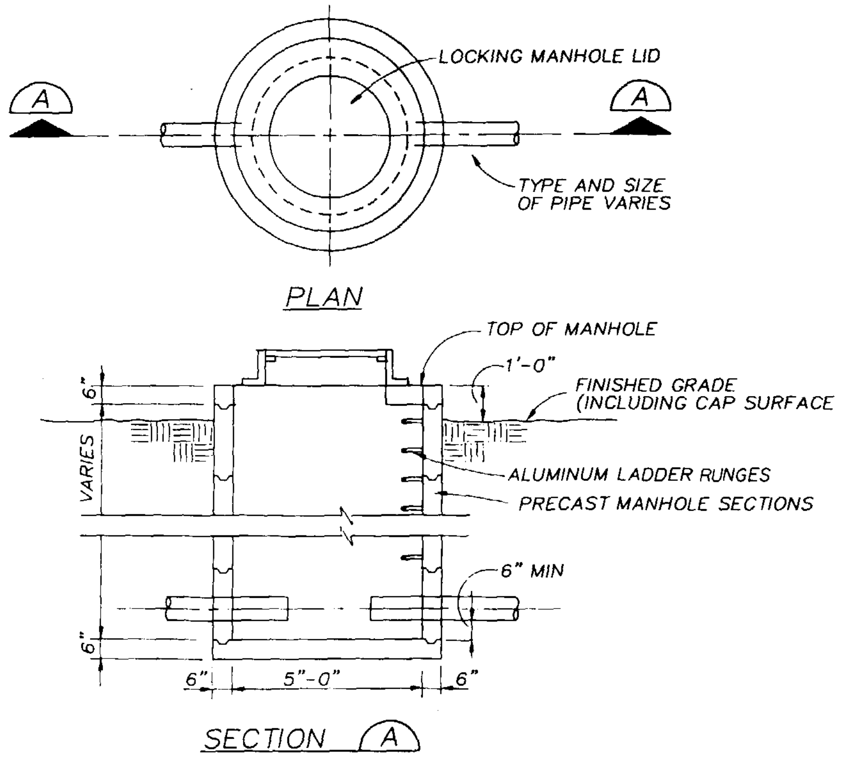
LEACHATE COLLECTION SYSTEM PROFILE

SCALE: 1"=10' VERTICAL
1"=200' HORIZONTAL

LEACHATE COLLECTION SYSTEM MANHOLE LOCATION COORDINATES

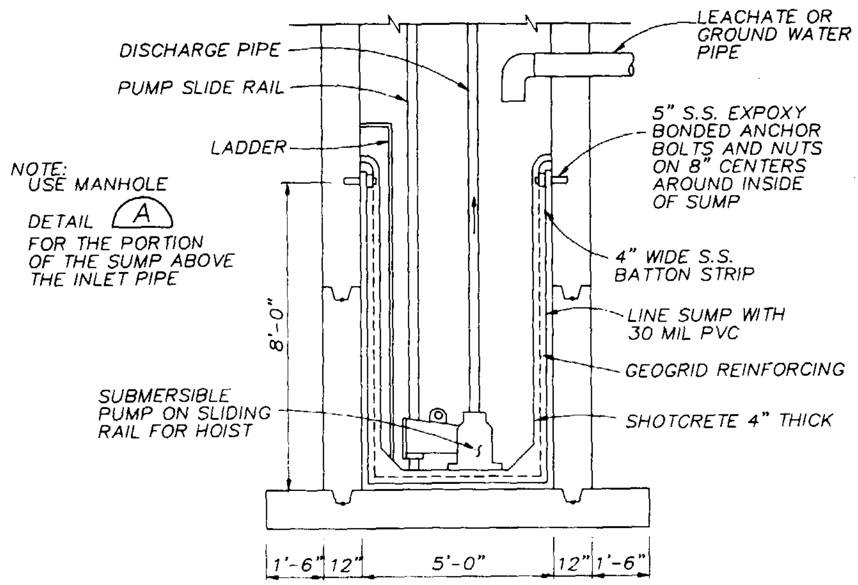
TO BE DESIGNED

MANHOLE NO.	EASTING	NORTHING	MANHOLE NO.	EASTING	NORTHING
LO			LS9		
LN1			LS8		
LN2			LS7		
LN3			LS6		
LN4			LS5		
LN5			LS4		
LN6			LS3		
LN7			LS2		
LN8			LS1		
LN9			LO		
LN10					



TYPICAL MANHOLE DETAIL A

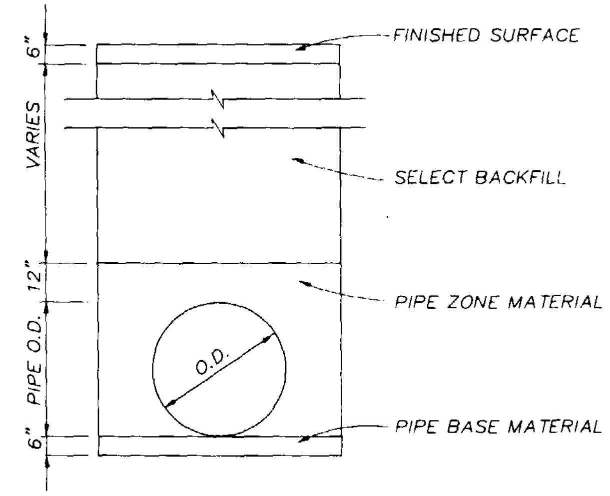
1"=30'



NOTE: USE MANHOLE DETAIL A FOR THE PORTION OF THE SUMP ABOVE THE INLET PIPE

TYPICAL SUMP DETAIL B

1"=30'



PIPING TRENCH DETAIL C

NOT TO SCALE

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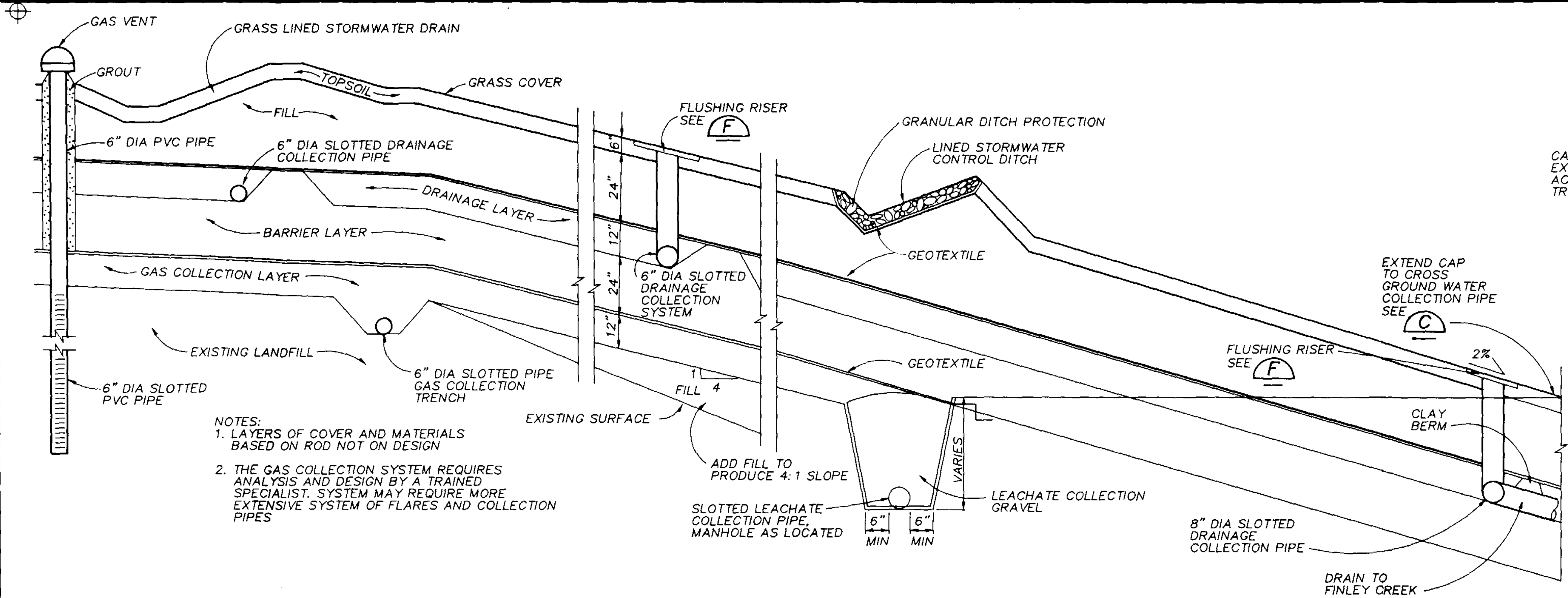
NORTHSIDE SANITARY LANDFILL AND ENVIRO-CHEM. CORP REMEDIAL DESIGN

LEACHATE AND GROUNDWATER COLLECTION SYSTEM PROFILES AND DETAILS

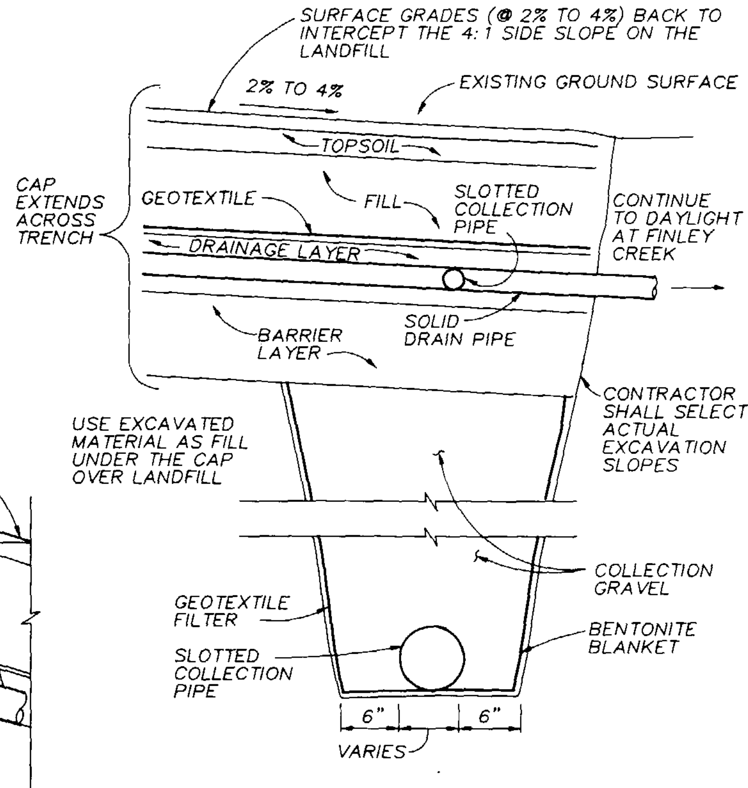
SHEET C-8
DWG NO
DATE SEPT 1988
PROJ NO.

PRELIMINARY

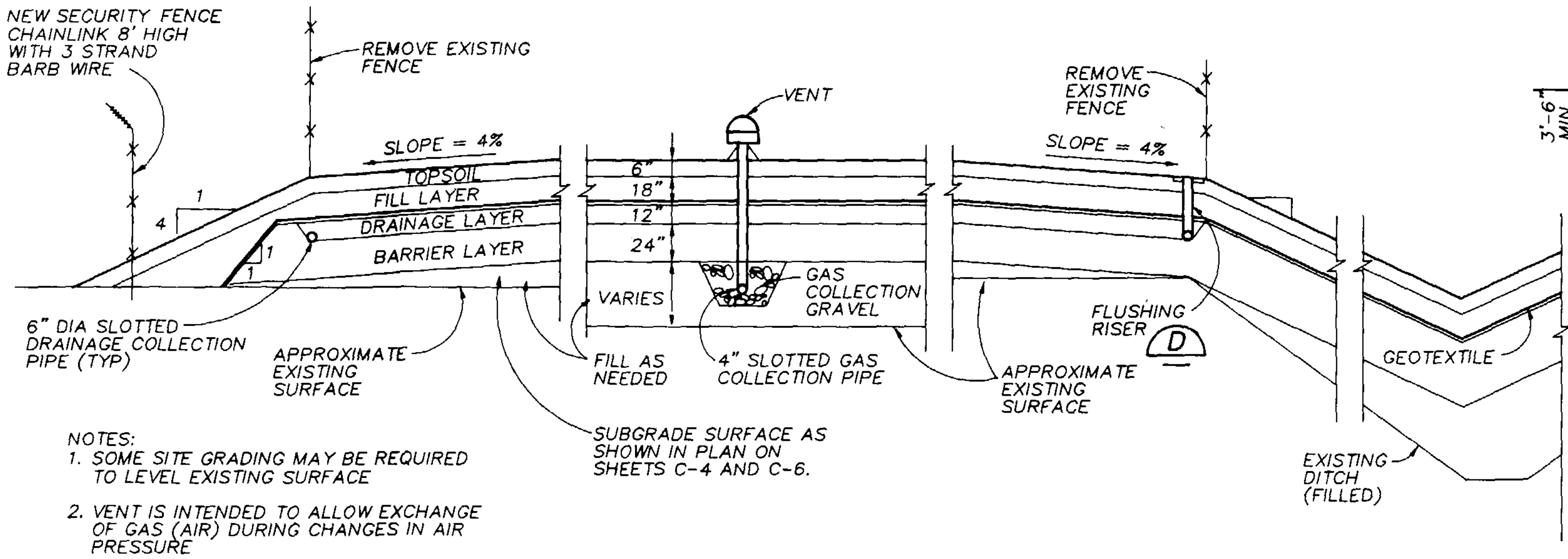


NOTES:
1. LAYERS OF COVER AND MATERIALS BASED ON ROD NOT ON DESIGN
2. THE GAS COLLECTION SYSTEM REQUIRES ANALYSIS AND DESIGN BY A TRAINED SPECIALIST. SYSTEM MAY REQUIRE MORE EXTENSIVE SYSTEM OF FLARES AND COLLECTION PIPES

NORTHSIDE LANDFILL COVER (A) C-5
SCALE 1"=2'

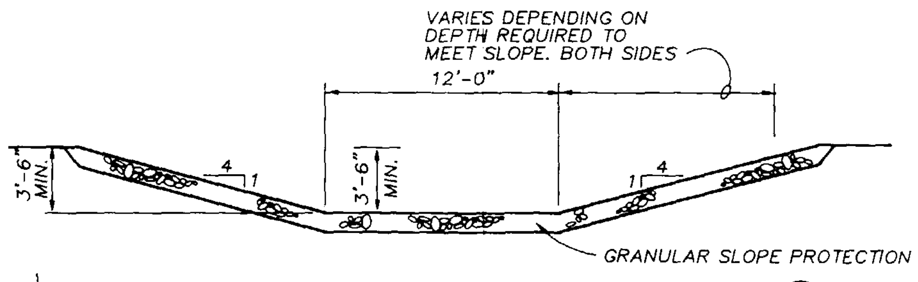


GROUNDWATER COLLECTION PIPE TRENCH SECTION (C)
NTS

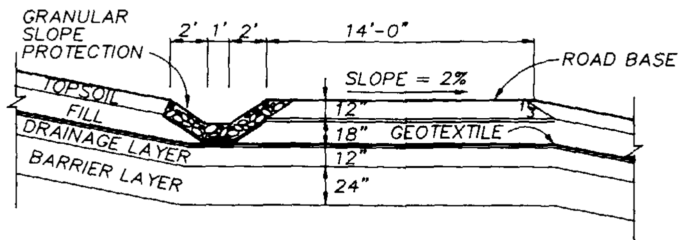


NOTES:
1. SOME SITE GRADING MAY BE REQUIRED TO LEVEL EXISTING SURFACE
2. VENT IS INTENDED TO ALLOW EXCHANGE OF GAS (AIR) DURING CHANGES IN AIR PRESSURE

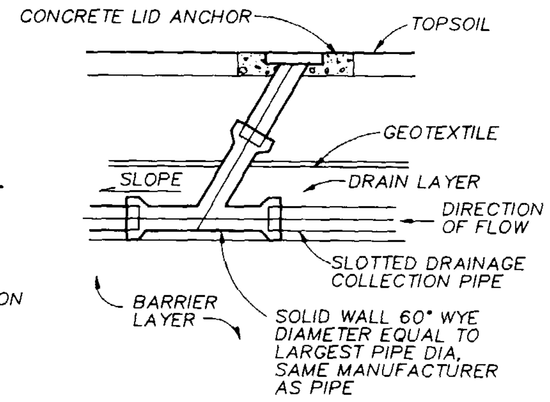
ENVIRO-CHEM CORPORATION COVER (B) C-4, C-6
SCALE 1"=5'



NEW FINLEY CREEK CHANNEL (X) C-1, C-4, C-5
SCALE 1"=5'

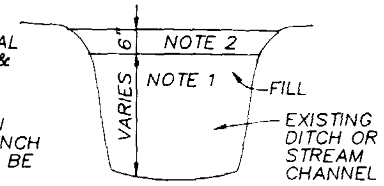


ACCESS ROAD (E) C-7
SCALE 1"=5'



FLUSHING RISER (F)
NTS

NOTES:
1. COMPACT FILL MATERIAL SO SURFACE MATERIAL CAN BE GRADED & SETTLEMENT WILL NOT OCCUR
2. PLACE TOPSOIL IN UPPER 6" OF TRENCH IF SURFACE IS TO BE SEEDED



STREAM & DITCH FILLING (G) C-1, C-4, C-5, C-8
NTS

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NORTHSIDE SANITARY LANDFILL AND ENVIRO-CHEM. CORP. REMEDIAL DESIGN	CAP, SURFACE WATER AND GROUNDWATER CROSS SECTIONS AND DETAILS	SHEET C-9 DWG NO DATE SEPT 1988 PROJ NO